DOCUMENT RESUME

ED 266 244 CE 043 430

AUTHOR Kaplan, Christine E.
TITLE Bridging the Skills Gap. Working Paper Part I: High Technology Industries.
INSTITUTION Wider Opportunities for Women, Inc., Washington, D.C.
PUB DATE Mar 84
NOTE 102p.; For Part II, see CE 043 431.
PUB TYPE Information Analyses (070)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS Adults; Aerospace Industry; Career Education; Communications; Computers; Data Processing; Demography; *Employed Women; Employment; *Employment Opportunities; *Employment Patterns; Females; *Futures (of Society); *Industry; Manufacturing Industry; Nontraditional Occupations; Salaries; Semiconductor Devices; Sex Discrimination; Sex Fairness; Space Exploration; *Technological Advancement; Telephone Communications Industry

ABSTRACT

In this working paper on high technology industries, a few representative industries are studied in detail, while an overview is also given of the group as a whole. The overview, which highlights the findings of selected studies of the unique characteristics of high tech industries, considers such issues as locational factors, occupational and employment characteristics, and structural changes in the economy. The section called Introduction to Industry Profiles highlights selected trends related to high technology industries that affect employment either directly or indirectly, including earnings, the role of women, and industry structure. Industry profiles are then provided for the semiconductor industry, computer industries (divided into electronic computing machinery industry and computer and data processing services industry), communications industries (divided into communication equipment industry and telephone communication industry), and guided missiles and space vehicles industry. Each profile discusses the products/services provided by the industry, employment and earnings data, occupational outlook, demographic characteristics with special focus on women, industry economic characteristics (including corporate identification, sales, international trade), and industry trends. A bibliography of principal published sources used in the analysis concludes each profile. Data tables dispersed throughout the text include tables showing male-female ratios in white collar and blue collar occupations in the industries considered. Discussions of demographic characteristics show generally that occupational segregation persists and that the majority of women employed in microelectronic-related businesses hold the lowest paid, lowest status jobs despite a relatively high level of participation. (YLB)

ED266244

BRIDGING THE SKILLS GAP
WORKING PAPER
PART I: HIGH TECHNOLOGY INDUSTRIES

By
Christine E. Kaplan
March 1984

A Project of the Women's Work Force Division
of
Wider Opportunities for Women, Inc.

CE043430

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

E Kaplan

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

HIGH TECHNOLOGY INDUSTRIES

Table of Contents

High Technology Industries - An Overview 1
General Characteristics 1
Occupational and Employment Characteristics 4
Structural Changes in the Economy 5

Introduction to Industry Profiles 7
Industry Selection 7
Employment and Earnings 8
The Role of Women 11
Industry Structure and Trends 11
Resources for Industry Profiles 15
Sources of Information About High Technology Industries 17

Industry Profiles

Semiconductor Industry 18
Industry Overview 18
Industry Description 18
Employment and Earnings 19
Demographics of the Workforce 21
Occupations and Outlook 24
General Industry Characteristics 26
Industry Trends 31
Sources of Information About the Industry 33

Computer Industries 34

Electronic Computing Machinery Industry 34
Industry Overview 34
Industry Description 35
Employment and Earnings 36
Demographics of the Workforce 37
Occupations and Outlook 39
General Industry Characteristics 42
Industry Trends 50

Computer and Data Processing Services Industry 53
Industry Description 53
Employment and Earnings 54
Demographics of the Workforce 55
Occupations and Outlook 55
Industry Characteristics and Trends 57
Sources of Information About the Industries 61

Communication Industries 62

Communication Equipment Industry 62
Industry Overview 62
Industry Description 63
Employment and Earnings 64
Demographics of the Workforce 65
Occupations and Outlook 68
General Industry Characteristics 69
Industry Trends 75

Telephone Communication Industry 76
Industry Overview 76
Industry Description 76
Employment and Earnings 77
Demographics of the Workforces 77
Occupations and Outlook 78
General Industry Characteristics 82
Industry Trends 84
Sources of Information About the Industries 86

Guided Missiles and Space Vehicles Industry 88
Industry Overview 88
Industry Description 88
Employment and Earnings 89
Demographics of the Workforce 89
Occupations and Outlook 90
General Industry Characteristics 93
Trends in Space and Missile Programs 96
Sources of Information About the Industry 98

HIGH TECHNOLOGY INDUSTRIES-AN OVERVIEW

High technology industries have emerged during recent years as the major driving force for change in the U.S. economy. The introduction of new products and their applications as well as automated production processes have far-reaching implications for employment, productivity, international competition, national defense and the general standard of living.

Although a significant amount of attention has been given to high technology no consensus has been reached that brings forth a generally-accepted definition of high tech. Furthermore, no definitive research studies have been published (to date) that encompass either the high tech industrial sector or analyze in-depth the broad spectrum of social, economic and political implications associated with technological development.

Progress is being made in these directions, however, as evidenced by the significant increase in literature on selected aspects of high technology. Newspapers, business periodicals, trade and professional associations, unions, educators and many others have contributed hundreds of articles and reports on various high technology topics. As a result, general concepts are taking shape that lend themselves to a characterization of high technology industries and the consequences of their development.

General Characteristics of High Technology Industries

Most classifications of high technology industries focus on businesses that exhibit some combination of the following attributes:

- o research and development expenditures above the national average for all industries
- o employment of technology-oriented workers greater than the average for all industries
- o technical nature of industry/high proportion of sophisticated (state-of-the-art) products
- o high degree of complexity associated with production processes

Since many industries are not necessarily characterized by all of the above, the results of studies that select different combinations of criteria are often based on different industries and consequently are difficult to compare with one another. Another complicating factor is the refinement of the industry analysis since many studies are based on broadly defined industry groups

while others cover industries at a more detailed level.* It is WOW's opinion that the most incisive analyses are those that work at the greatest level of refinement, since broader approaches often include industries that do not possess high tech characteristics.

Most definitions of high technology industries include manufacturers of computers, electronic components, communications equipment, guided missiles and space vehicles (industries largely dependent on microelectronics technology) and drugs. Others add to this core group chemical manufacturers, petroleum refiners, electrical transmission and industrial apparatus, aircraft, scientific instruments, computer and data processing services and R&D laboratories. The broadest definitions encompass as many as forty industries at the 3-digit SIC level from crude petroleum and natural gas to radio and television broadcasting.

WOW's general approach to the research for the **Bridging the Skills Gap** Project has been to look at industries at the most detailed level which display all of the above characteristics. The results of WOW's analyses are presented as **Industry Profiles** in this section of the **Working Paper.** We do not discount, however, the value of other high tech industry studies (despite definitional problems) because these reports provide useful insight into the broader implications associated with high technology industries and their influence on employment and the economy in general. The following sections highlight the findings of various studies pertaining to a few of the unique characteristics of high tech industries.

Locational Factors

Selection Criteria

A recent study covering the location of high tech firms (Location of High Technology Firms and Regional Economic Development prepared for the Joint Economic Committee (JEC) of the U.S. Congress) indicates that these kinds of businesses choose locations based on criteria different from those of traditional manufacturing industries.

---

*The most frequently used classification scheme for industries is the federal government's **Standard Industrial Classification (SIC)** coding system that classifies industries at three separate levels of aggregation. The most refined level is represented by a four-digit code, for example SIC 3674 which represents the semiconductor and related devices industry. Four-digit industries are grouped under three-digit codes, in the case above, SIC 367 -- electronic components and accessories. The broadest categorization appears at the two-digit level with SIC 36 covering all electrical and electronic equipment industries or 8 three-digit industry groups and more than 16 four-digit industries.

According to the results of a survey that provided the data base for the JEC study, 700 responding high tech companies ranked the following factors (presented in order of importance) as the most significant in choosing a region in which to locate: availability of skilled labor, labor costs, tax climate, academic institutions, cost of living and transportation. These criteria are very different from traditional manufacturing industries that are more likely to give higher consideration to factors such as access to raw materials, energy supplies, markets and transportation among others.

After a region is selected the primary factors that influence the actual location of a high tech worksite within a region are the availability of workers, state and/or local taxes, and community attitudes toward business. It is important to note that while the availability of labor was the dominant factor the highest preference was for technicians followed by professionals and lastly unskilled workers. This preference may be based on the inference that technical workers are less mobile than professionals such as engineers and scientists who are more likely to relocate for purposes of employment.

The JEC study also indicates that location criteria may change for more mature businesses. At the outset, new growing firms have a tendency to locate near other high tech businesses in order to take advantage of technology transfer and skilled labor as well as other specialized resources associated with high technology centers. As a high tech company matures (i.e., its production processes become routine and its markets are clearly defined) it becomes less dependent on a high tech infrastructure. At this stage of development firms may weigh other factors in selecting sites for plant expansion that are more traditional, e.g. the prevailing wages rates of a given locale, land costs, and taxes that minimize the cost of production. Most firms continue to base their corporate headquarters and R&D operations near the high tech center, however. Furthermore several studies covering high tech industries indicate high employment concentration in or near large metropolitan areas.

Two major examples of areas that have met these location requirements are California's Silicon Valley and Boston's Route 128 Corridor. In retrospect it is not surprising these two high tech centers developed, based on the existence of supportive infrastructures. California has been the home of the aerospace industry and consequently a center for engineers and scientists. Massachusetts retained the infrastructure from its declining industrial base (including a skilled labor force) and began structuring its high technology base years ago. In addition, both of these areas have prestigious educational institutions that support high tech R&D efforts and provide highly specialized technical workers.

Regional Trends

The most significant employment growth associated with high tech industries has occured in the Far West and the Northeast (excluding Connecticut and Rhode Island). High tech centers such as California's Silicon Valley and Boston's Route 128 have contributed not only to state economic growth but have generated positive employment gains for other states in their regions.

During the period 1975 to 1979 California led all states in terms of actual employment growth (number of jobs) in high tech industries. Massachusetts, Texas, Florida, New York, Minnesota and North Carolina followed (in descending order). In terms of increased employment (percentage change) Nevada, Washington, New Hampshire, Utah, Florida, Colorado and Arizona demonstrated the most dramatic growth rates.

States in the Far West and New England benefitted the most during these years, followed by Southeastern and Southwestern states, which also experienced healthy growth patterns in high technology employment. In contrast, manufacturing states in the Great Lakes and Mideastern regions did not keep pace. In addition, respondents to the JEC survey indicated preferences for future plant locations in the Far West, New England and Southwest as well as overseas.

One recent observable trend is the spreading out of high tech manufacturing facilities from high tech centers to satellite locations in nearby states. The more developed high tech core areas are becoming constrained by shortages of skilled labor, increasing taxes and housing costs, congestion and insufficient room for expansion. There is also evidence that the highest proportion of new plants are being constructed in areas with relatively low numbers of high tech firms such as the Midwest, Southeast and Southwest. These new plants are primarily production facilities, however, and not necessarily new companies. In addition, many high tech manufacturers are selecting plant locations in foreign countries with lower wage rates.

Occupational and Employment Characteristics

One of the most critical factors associated with the development of high tech industries is the availability of a highly skilled labor force. The Bureau of Labor Statistics (BLS) has defined technology-oriented workers as engineers, life and physical scientists, mathematics specialists, engineering and science technicians and computer specialists.

In a recent report ("High Technology Today and Tomorrow: A Small Slice of the Employment Pie" by R. Riche, D. Hecker and J. Burgan in the November 1983 edition of the Monthly Labor Review) the BLS differentiates technology-oriented workers from others who use or repair high tech equipment as follows:

> Most workers in technology-oriented occupations are directly involved in developing or applying new technologies. Their work requires in-depth knowledge of theories and principles of science, engineering, and mathematics underlying technology--a knowledge that distinguishes them from computer operators, computer service technicians and other high tech machinery repairers, or workers in a wide range of occupations who use word processing machines, computers or other high technology products, but rarely have--or need--such in-depth knowledge. Workers in these technology-oriented occupations generally need specialized post-high school education in some field of technology--ranging from an associate degree or its equivalent to a doctorate--education with a thorough high school preparation in science and mathematics as a prerequisite.

During the period 1972-1982 employment levels of workers in high technology (based on the broadest industry definition) grew most dramatically in the following industries: computer and data processing services (235%), miscellaneous communications services (206%), crude petroleum and natural gas (102%), office and computing machinery (89%) and optical instruments (85%). It has been estimated that high tech industries as a group generated 5-15% of all new jobs during this time frame.

Projections made by the BLS for the period 1982-1995 indicate employment in all U.S. industries will increase by 23 million to 29 million new jobs. It has been estimated that from one million to five million of these jobs will be offered by high tech employers. These projections indicate the bulk of employment expansion over the next decade will take place in non-high technology environments. Consequently the BLS advises job-seekers and government entities trying to attract jobs to their locales not to limit their searches to high technology industries.

Structural Changes in the Economy

Many industry analysts have observed that the decline in employment in traditional manufacturing or "smokestack" industries combined with the emergence of high technology industries is posing serious problems for many workers. Blue collar workers in particular are affected in two major ways--most high tech companies are not locating in major traditional manufacturing areas where displaced factory worker populations are present and the majority of blue collar workers do not possess the requisite skills for many high tech jobs. Therefore, while overall employment projections appear reassuring, the structural changes underlying these statistics are significant and have serious implications for the regional and occupational distribution of employment during coming years.

A recent analysis of these trends ("Structural Change in the U.S. Economy: 1979-87 High Technology versus Smokestack Industries" by J. Cremeans in the Department of Commerce's U.S. Industrial Outlook 1984) notes the shift from blue collar to white collar jobs is having a profound effect on employment in selected mid-eastern and midwestern states. According to this report the number of new jobs in high tech industries increased by 32,000 between 1979 and 1983 in Ohio, Indiana, Illinois, Michigan and Wisconsin while employment in these states' smokestack industries declined by 276,000 jobs during the same period. Furthermore, projections through 1987 indicate job gains in both employment sectors (high tech and smokestack) in these states will result in a net loss when compared with 1979 employment levels.

Another significant change that is taking place is related to earnings. According to Department of Commerce (DOC) industry specialists, wages in the aggregate may be declining. Average wages of production workers in smokestack industries were higher than the earnings of their counterparts in high tech ($12.84 versus $9.46 per hour) during 1982. Therefore DOC analysts conclude that while new jobs in high tech will compensate for slower growth or losses in smokestack employment "...the net result may be to decrease the proportion of higher-paying blue collar jobs and increase the proportion of lower-paying blue and white-collar jobs."

Although the DOC analysis was limited to ten high tech industries and eight smokestack industries the findings point toward several implications for the economy that warrant serious consideration by policy makers. The DOC identified the following:

- Growing regional unemployment problems for youths and minorities
- A possible continuation or acceleration of the decline in union membership
- Continuing demands for protection from foreign imports
- Persistent financial problems for the smokestack cities of the country
- Continuing support for some form of "industrial policy"
- Continuing demand for new, government-financed education, training, and retraining programs

INTRODUCTION TO INDUSTRY PROFILES

Industry Selection

Given a lack of consensus about the definition and classification of high technology industries, the number of industries and diversity of technologies associated with the group, WOW decided to select a few representative industries for detailed study while it continued its oversight of the group as a whole. It was WOW's opinion that resources would be best expended and findings more meaningful if we concentrated on categories of businesses that encompass the most widely accepted definitions of high tech industries, i.e. those characterized by a high proportion of technology-oriented workers and R & D expenditures.

We also believed it was important to select industries that have large laborforces (more than 100,000 workers), that manufacture high tech products used in a variety of downstream employment sectors, and that are projected to grow throughout the decade. The industries that met these criteria are:

- Semiconductors and related devices (SIC 3674)
- Electronic computing machinery (SIC 3573)
- Radio and television communication equipment (SIC 3662)
- Guided missiles and space vehicles (SIC 3761)

In addition WOW chose to examine three related industries including computer and data processing services (SIC 737), telephone and telegraph equipment (SIC 3661) and telephone services (SIC 4811). For the most part the growth of these high technology industries stems from advances in microelectronics technology.*

In the preceding **Overview** we summarized selected studies of high tech industries as a group. In general we consider the findings of these studies to be consistent with our examination of selected industries at a more detailed level. The following paragraphs highlight selected trends we've identified regarding high technology industries that affect employment either directly or indirectly. We encourage readers to review the individual profiles, however, to gain a better perspective on the unique characteristics of individual high technology industries.

---

* At the start of the project we planned to investigate manufacturers of medical instruments, which would have led to an analysis of biotechnology and other medical/health-oriented technical fields. Unfortunately we were unable to pursue this branch of high tech given data inconsistencies and other methodological problems. We do consider this area important to the high tech dialogue, however, and hope studies will be forthcoming that address technological changes in biotechnology and related fields that affect employment.

Employment and Earnings

High technology industries employ a greater proportion of white collar than blue collar workers and the differential between the two groups is growing. Two primary factors that contribute to the shift away from production employment are increased utilization of automated equipment used in manufacturing operations and growth in overseas (offshore) activities.

Plant automation is accelerated in high tech industries because member companies are the designers and developers of the underlying technology. Furthermore, many companies are subjected to intense price competition from other domestic manufacturers and foreign producers, which has prompted efforts to reduce production costs. This latter factor has also caused many companies to choose overseas sites for production activities where inexpensive labor is available to perform labor-intensive production operations that do not require highly skilled personnel.

A third factor contributing to higher participation rates for white collar personnel is the reliance of high technology industries on skilled professionals and technicians. All of these industries are extremely "knowledge-intensive" and consequently key technical personnel constitute a major ingredient in the formula for corporate success.

One unfortunate gap in the data base developed for this study is industry-specific earnings data for salaried (primarily white collar) employees. Statistics are available for major occupational classifications and these are provided in the **Occupational Profiles.** The federal government does report wage data for hourly workers by industry, however, and these statistics are summarized in **Table A** along with employment data for the industries WOW examined.

Among the group, wages are highest for production and nonsupervisory workers in the guided missiles and space vehicles industry and telephone services. Although we are unable to offer any detailed explanation regarding wage differentials among the industries it does appear that union membership is more prevalent in these two industries and may contribute to higher earnings levels. In general we found little unionization in high tech firms, especially companies that have been established in recent years.

Overall employment in high tech industries is expected to grow in the future as evidenced by the projections of various economic forecasters. Unfortunately no statistical breakdowns are available that indicate levels of production employment in these industries. The competitive attributes of high tech industries are most often tied to the introduction of products and services that reflect the latest technological concepts. As a result there is significant demand for technology-oriented workers who can conceptualize, design and construct state-of-the-art equipment and systems. Job opportunities will probably be the most

TABLE A.

EMPLOYMENT AND EARNINGS STATISTICS
FOR SELECTED HIGH TECHNOLOGY INDUSTRIES

1982 Averages

Industry	All Workers	Non-supervisory or Production Workers	Women Workers	Nonsupervisory or Production Workers' Weekly Wages	Weekly Hours
	(thousands omitted)				
Semiconductors and related devices	230.4	91.4	105.1	321.55	39.6
Computers and peripheral equipment	419.5	157.6	155.5	326.65	41.4
Communications equipment	555.7	259.6	209.8	385.12	40.2
Guided missiles and space vehicles	100.7	29.2	24.1	460.73	41.1
Computer and data processing services	357.5	292.2	170.6	320.78	37.3
Telephone communication services	1,063.8	783.0	520.7	427.27	39.8

Source: U.S. Department of Labor, Employment and Earnings (March 1983), Tables B-2, B-3 and C-2.

TABLE B.

EMPLOYMENT PROJECTIONS
FOR SELECTED HIGH TECHNOLOGY INDUSTRIES

Industry	Actual Employment 1979	Actual Employment 1982	Projected Employment Based on Moderate Growth 1990	Projected Employment Based on Moderate Growth 1995
	(thousands omitted)			
Electronic components (including semiconductors)	525	561	745	850
Computers and peripheral equipment	339	428	586	694
Telephone and telegraph equipment	165	148	185	209
Radio and television communication equipment	357	424	433	460
Guided missiles and space vehicles	81	105	130	140
Communications services (excluding broadcasting)	1,121	1,199	1,379	1,593

Source: Personick, Valerie A., "The Job Outlook Through 1995: Industry Output and Employment Projections", Monthly Labor Review (November 1983), 24-36, Table 5.

favorable for recent graduates in relevant disciplines and those professionals who continue to enhance their skills through additional training and education. **Table B** presents recent employment projections for selected industries (actual data varies from Table A because different data sources and levels of industry aggregation were used.)

The Role of Women

Numerous photographs of professional technical women in corporate reports and other publications often leave the impression that women "have made it" at all levels in high tech industries. Similarly, many company representatives and industry analysts conjecture that the growth of these industries is creating new occupations that are not sex-stereotyped, thus creating an avenue of equal opportunity for all prospective employees. Although women are represented in high tech in all occupational categories their participation rates to date are disappointingly low in high level professional and technical positions. **Table C** presents occupational data covering women in four high tech industry groups based on employer reports to the Equal Employment Opportunity Commission.

According to our sample of industries in **Table C** nearly 50% of all employees were classified as nonclerical white collar workers --less than 20% of women workers held these kinds of jobs. The majority of women in these industries work as operatives or office workers, in other words in the lowest paying and least skilled positions. Furthermore, women represent the most vulnerable employee group (by virtue of their predominance in production occupations) during times of economic recession when layoffs may occur, when companies relocate production operations overseas, and when further automation is introduced to the manufacturing process.

The next table (**Table D**) provides a breakdown of participation rates for women by industry group. In three of the four groups women represented about 40% of all employees--the exception being guided missiles and space vehicles where women held only 21% of the jobs in 1982. A quick review of these data underscores the weak presence of women in all but the lowest paying/status occupations. More detailed demographic data are presented in the individual **Industry Profiles.**

Industry Structure and Trends

The dynamic nature of high tech industries lends little support to constructing a profile of the "typical" industry or corporation. Firms in these industries have work forces ranging from a handful of employees working in "someone's garage" to thousands of workers laboring in large-scale facilities around the world. The corporate compositions of most of the manufacturing groups WOW has studied are constantly changing, with new companies regularly entering the high tech arena and periodic "shakeouts" occuring when particular markets become overcrowded.

TABLE C.

DISTRIBUTION OF JOBS -- AVERAGES FOR FOUR INDUSTRIES*

1982

	ALL WORKERS	WOMEN WORKERS
Number of workers	1,300,322	553,036
Total (percentages)	100.0	100.0
White collar workers	60.1	45.8
Officials and managers	12.9	3.7
Professionals	21.2	8.8
Technicians	11.6	5.9
Sales workers	1.3	0.7
Office and clerical workers	13.2	26.7
Blue collar workers	38.6	53.5
Craft workers	9.3	4.8
Operatives	26.4	44.0
Laborers	2.9	4.7
Service workers	1.2	0.7

*Data covers most manufacturers of office and computing machines (SIC 357), communication equipment (SIC 366), electronic components (SIC 367), and guided missiles and space vehicles (SIC 376). Data represents most detailed breakdown available for occupational subgroups by industry and is considered representative for the industries under study.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

TABLE D.

PERCENTAGE OF WOMEN EMPLOYEES FOR FOUR INDUSTRIES*

1982

	Office & Computing Machinery (SIC 357)	Communi-cation Equipment (SIC 366)	Electronic Components (SIC 367)	Guided Missiles/ Space Vehicles (SIC 376)
Total Number - Women Employed	116,685	153,719	250,799	31,823
Women as a % of All Workers	37.4	40.2	45.0	21.6
White collar	30.8	29.6	32.0	22.5
Officials and managers	12.7	10.4	13.1	4.4
Professionals	21.5	14.4	16.1	12.1
Technicians	15.3	16.6	26.1	20.6
Sales workers	18.4	14.8	24.3	13.0
Office and clerical workers	81.7	78.5	81.5	76.8
Blue collar workers	54.5	53.8	61.5	19.0
Craft workers	22.6	19.3	25.7	8.7
Operatives	63.7	63.2	71.7	32.7
Laborers	48.6	58.9	70.7	50.7
Service workers	22.6	24.8	21.6	28.9

*The columns in this table are not additive. Each number represents the percentage of women in each occupational category by industry, e.g. women account for 12.7% of all official and managerial positions in the office and computing machinery industry.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

Recent analyses of high tech industries indicate, however, a long-term trend toward consolidation within industry groups and among separate groups that are founded on microelectronics technology. Several factors contribute to this trend. While the cutting edge is technology--the company that is the first to introduce a state-of-the-product often succeeds--more traditional economic factors play a major role in high tech as they have in other industries. These variables include earnings, market experience, production capacity and human resources, among others.

Capital requirements have become a major barrier to many firms, based on the movement toward sophisticated automated equipment, frequent changes in product lines that require continual investment in new equipment, and rapid expansion beyond existing capacity as demand for high tech products grows. In many cases only larger, more diverisified companies can sustain this kind of growth (especially during periods like the recent recession). As a result, many successful but cash-poor firms are entering joint ventures with industry leaders while others are merging or being acquired by major corporations in the same business or others outside the industry that are dependent upon a supply of particular products and/or services. The end result of this type of activity may eventually lead to greater concentration among high tech industries as larger companies expand horizontally.

Another trend that has emerged is the blurring of industry lines in the microelectronics field. All the industries WOW has examined are interconnected via technology and many industries use the products of others in the group. While there appears to be a race among major corporations like IBM and AT&T to become proficient in a variety of microelectronic product and service areas there undoubtedly will continue to be resistance from larger specialized firms who wish to remain independent. The fact that new advanced technologies offer a broad spectrum of future undefined applications suggests the field will remain open for the short run at the very least.

Another critical ingredient to the high tech success formula is human capital. Highly skilled personnel are essential to research and development activities as well as to other operational needs ranging from production to marketing. At present there is significant demand for technical workers and high tech firms are directing their recruitment efforts toward recent college graduates and to a lesser extent experienced personnel in technical fields as well as management and marketing.

During the past several months WOW has reviewed many reports that decry shortages of qualified personnel to meet current and future employment needs of high tech industries. Deficiencies in the U.S. educational system have been cited as the primary sources of the problem and these have been addressed by numerous legislative proposals aimed at improving math and science programs. (Attention has also been given to retraining present members of the labor force but to a lesser degree.)

In general high tech industries have responded in two ways. One primary thrust has been toward improved educational programs with most industry involvement or support at the post-secondary level. Another emerging trend is the development of corporate training programs that go beyond traditional on-the-job training to enhance employee skills and promote job development. It appears that most employer programs are oriented toward senior-level professional personnel. At present, however, most employers provide for advanced employee training through tuition-reimbursement programs at nearby colleges and universities. Advanced training and retraining can be a critical factor for high tech employees since much of their work is tied to rapidly changing technologies that often require skills enhancement.

It is also important to note that various employment studies have challenged the severity of the shortage of qualified technical personnel. Although WOW has been unable to clear up this controversy it is important to remember that high tech industries as a group will offer limited job opportunities in the aggregate.

One other major trend that has dampened the success of high tech industries in the U.S. has been an erosion in the balance of trade. This relative decline has resulted from increased foreign competition in U.S. markets for selected high tech products and from barriers that restrain access to foreign markets. At present the federal government and others are assessing the situation and developing strategies aimed at reversing the trend. Many of these proposals are related to strengthing the pool of skilled workers to meet industry labor requirements. (The international trade scenarios for individual industries are discussed in the **Industry Profiles.**)

Industry Profiles

The **Industry Profiles** reflect WOW's efforts to provide meaningful descriptions and analyses of key high technology industries. The principal research activity has been to identify, review and analyze information and data from a variety of sources, including standard business periodicals and references, trade publications, government reports and statistics, corporate annual reports, Congressional testimony and legislation, and a variety of other relevant secondary source materials related to high tech, automation and employment.

Concurrently, contacts (written, telephone and personal interviews) were made with industry experts, corporate representatives, labor economists and others in the field to supplement, clarify and confirm the information base and analysis. Primary contacts included:

- major trade and professional organizations
- major corporations in each industry

- government analysts from the Departments of Commerce and Labor, the Office of Technology Assessment and other federal agencies
- key Congressional staff members
- experts from academia, private research institutions and firms, etc.

In addition, WOW has participated in a large number of conferences, meetings, Congressional hearings and other forums convened to discuss high tech employment issues.

From these efforts WOW amassed a significant collection of resource materials and statistics that formed the information base for the profiles. The profiles cover a variety of economic and employment issues related to the individual industries. Each profile discusses the products/services provided by the industry, employment and earnings data, occupational and demographic characteristics, industry economic characteristics, (including corporate identification, sales, international trade, etc.) and industry trends. Also included at the end of each profile is a bibliography of principal published sources used in the analysis.

Standard Industrial Classification (SIC) Codes

Industry and employment data used throughout the **Industry Profiles** are based on the Office of Management and Budget's "Standard Industrial Classification" system. This system was originally developed for use within the government for statistical purposes but is now widely used by individual businesses for classifying customer and suppliers as well as by nongovernment research and business organizations, trade and professional associations and others who compile statistics that supplement those provided by federal agencies. In brief, each establishment (worksite) in the nation is assigned an industry code on the basis of its principal product or group of products produced or distributed, or services rendered.

Principal Statistical Sources

The primary sources of employment data used in the **Industry Profiles** are Employment and Earnings (a monthly statistical report published by the Department of Labor's Bureau of Labor Statistics (BLS)), selected articles published in the Monthly Labor Review (another BLS publication) and the U.S. Industrial Outlook (an annual publication of the Department of Commerce's Bureau of Industrial Economics) which uses BLS and Bureau of the Census data to formulate its own employment statistics. The data used in the demographic sections of the profiles are based on individual employer reports (EEO-1 forms) filed with the Equal Emplpyment Opportunity Commission. The primary sources of industry data were the 1983 and 1984 editions of the U.S.

Industrial Outlook. In addition many other sources of industry statistics were used and are clearly identified in the individual tables that are presented throughout the **Industry Profiles.**

Sources of Information About High Technology Industries

"America Rushes to High Tech for Growth", Business Week (March 28, 1983), 84-98.

Cremeans, John E. et al, "Structural Change in the U.S. Economy: 1979-87, High Technology Versus Smokestack Industries", U.S.Industrial Outlook 1984. Washington, D.C.: U.S. Government Printing Office (1984), 39-45.

International Trade Administration, An Assessment of U.S. Competitiveness in High Technology Industries. Washington, D.C.: U.S. Department of Commerce (February 1983).

Meisner, Charlotte, High Technology Employment: Massachusetts and Selected States 1975-1981. Boston, Mass.: Massachusetts Division of Employment Security (July 1982).

Office of Technology Assessment, Technology Innovation and Regional Economic Development [Background Paper: Census of State Government Initiatives for High Technology Industrial Development]. Washington, D.C.: U.S. Government Printing Office (1983).

Premus, Robert, Location of High Technology Firms and Regional Economic Development [Staff Study prepared for Subcommittee on Monetary and Fiscal Policy of the Joint Economic Committee, Congress of the U.S.] Washington, D.C.: U.S. Government Printing Office (May 1983).

Riche, Richard W.,Daniel E.Hecker and John U. Burgan, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie" Monthly Labor Review (November 1983), 50-58.

SEMICONDUCTOR INDUSTRY

Industry Overview

The semiconductor and related devices (semiconductor) industry represents one of the most advanced and dynamic manufacturing groups in our economy. In essence, the industry forms the heart of "high tech" industries because its products have become the building blocks for nearly all types of electronic equipment and are considered a critical component in the world's technological progress. The key to this progress is the integrated circuit.

The industry is both capital and labor intensive. Rapid technological changes associated with the industry require significant outlays for research and development as well as physical equipment. The success/competitive advantage of the industry requires highly skilled personnel to conceptualize, develop, manufacture and market semiconductor products in both domestic and international markets.

Industry employment averaged 230,400 in 1982, with women holding 45% of total jobs. Although participation rates for women are high, about two-thirds work as operatives or clerical workers. In contrast, two-thirds of men in the industry are employed in management, professional, or technician positions.

The near-term outlook for the industry is one of growth -- at present U.S. manufacturers of semiconductors cannot meet the demand for these products and as a result are expanding production capacities and hiring more personnel. There are approximately 300 corporations making these products today. Leadership (in terms of production) is shared by companies that produce semiconductors primarily for sale to others and businesses that manufacture semiconductors for their own use rather than for external markets.

Industry Description

The semiconductor industry is one of seven industries included in the electronic components (components) manufacturing group as defined by the Department of Commerce (DOC). The other industries are electron tubes, electronic capacitors, electronic resistors, electronic coils and transformers, connectors and miscellaneous electronic components.

Establishments that specialize in semiconductor manufacture are classified under SIC 3674 and produce semiconductor and related solid state devices such as semiconductor diodes and stacks including rectifiers, integrated microcircuits (semiconductor networks), transistors, solar cells, and light sensing and emitting semiconductor (solid state) devices. A semiconductor is any of various crystalline substances (usually silicon) that has electrical conductivity greater than insulators but less than good conductors (metals) at room temperature. An integrated circuit is an array of diodes, transitors and other circuit parts formed on a single piece of silicon crystal (chip) arranged and interconnected to perform the function of an electronic circuit.

The integrated circuit has revolutionized the nature of industry and commerce based on its contribution to computer and related microelectronic technologies. Its impact is pervasive throughout commerce -- integrated circuits are used in data processing and office equipment, manufacturing process control equipment and other automated systems, laboratory and medical instrumentation, telecommunications systems and automobiles -- as well as in our homes -- these devices have given us personal computers, handheld calculators, digital watches, VCRs, and a variety of other readily-accepted consumer products.

The development of the semiconductor industry has had a profound impact on other industries in the components group because products such as the integrated circuit have displaced other components like resistors, capacitors and transistors in many types of equipment and products. In addition, the semiconductor industry itself is in a state of constant change as it moves towards developing new technologies by refining its own manufacturing processes and facilitating the creation of new products produced by itself and other manufacturers.

Employment and Earnings

During 1982 manufacturers of electronic components employed 568,000 workers with 57% engaged in production jobs. Approximately two out of every five workers (40%) in the group were employed by semiconductor manufacturers. Since 1972 the proportion of production workers in the semiconductor industry has declined from 60% to slightly less than 40% in 1982 when total employment averaged 230,400.

There are two primary factors that have influenced this change in the ratio of production to total employment in the semiconductor industry. The first is the development of overseas manufacturing facilities set up by U.S. manufacturers. The second is the steadily increasing requirement for more highly skilled personnel since the industry's growth and maintenance of competitive position are based on offering the most sophisticated, state-of-the-art products.

During the late 1960s many semiconductor manufacturers established assembly operations overseas in low-cost areas in Asia, Latin America and Europe. The offshore move of the most labor intensive industry activity -- assembly -- was aimed at reducing costs and improving the competitive position of U.S. firms in both domestic and foreign markets. The most recent data we found estimated offshore employment at 85,000 in 1974. According to industry analysts overseas employment has grown at rates comparable to the industry's production employment within the U.S.

Industry analysts appear divided on whether the relative number of production workers will continue to erode. Some analysts argue that the introduction of more expensive and sophisticated (automated) production and processing equipment will lead to a decline in the proportion of production workers in the semiconductor industry. Others indicate that at present the ratio may stabilize at current levels (about 40%) despite the introduction of automated equipment in some plants and that other economic factors may intervene which would influence this trend. Based on sketchy information, we can only speculate that offshore employment may decline in importance as technological improvements in production processes occur.

Employment in the semiconductor industry rose steadily in 1983 with total employment reaching 243,000 in October 1983 (including 104,300 production workers). Recent data reported by the Bureau of Labor Statistics covering future employment in all components industries indicate increases of 33% by 1990 and 52% by 1995 (over 1982 levels) based on a moderate growth scenario. These estimates translate into 164,000-232,000 new jobs in components manufacture by 1990 or 294,000-301,000 jobs by 1995.

Although comparable projections were not available for the semiconductor industry, it can be assumed that the industry is likely to account for a significant proportion of new jobs in components manufacturing as it continues to increase its share of these markets. According to industry analysts about 90% of the increase in components employment at present is attributed to semiconductor companies and other manufacturers who utilize semiconductor-related technologies such as producers of printed circuit boards.

The average hourly earnings for production workers in the semiconductor industry were $8.12 in 1982 with weekly earnings averaging about $322, or $16,000 per year. Most production workers were on the job an average of 39.6 hours per week with 2.4 hours of overtime. Over the past few months earnings and hours have increased as the industry has begun to recover from the recession. In October 1983, the average weekly wage was $361.85 based on production workers putting in 41.4 hours of work per week with 3.6 overtime hours. Comparable statistics are not reported for other (salaried) employees.

Demographics of the Workforce

Women have consistently represented about 45% of the semiconductor labor force for the past several years. In 1982, 105,000 women were employed by the industry. Unfortunately, detailed employment data covering women in specific occupational categories in the semiconductor industry are not compiled on a regular basis. As a result we have had to rely on disaggregated employment statistics for the entire components industry group.*

The majority (73%) of women working in the components industry are White. Among minority women in the industry -- these women represent about 12% of total industry employment -- 38% are Black, 42% are Hispanic and 20% are Asian or Pacific Islander women. As **Table I-A** shows, women are heavily represented in office/clerical positions and as blue collar operatives and laborers.

Despite the high overall participation rates for women in component manufacturing -- nearly 1 of every 2 employees -- women are underrepresented in better paying, higher skilled jobs. During 1982, women held only 13 percent of official and managerial positions and about 17% of professional jobs. Among other non-clerical white collar occupations, women held about 1 out of every 4 technician and sales positions. Although women represented about 62% of blue collar workers in 1982, they were most often relegated to lesser skilled jobs with only 1 out of every 4 employed as craft workers.

An analysis of the occupational distribution in the components industry demonstrates that about 55% of all workers held white collar jobs in 1982 and more than one-half of these were professional or managerial. Only one out of every ten women in this industry group held these kinds of white collar jobs (minority women held less than 3%) while nearly one out of every two men held jobs in these categories. Moreover, 68% of all men employed in components manufacture held white collar jobs.

Most women were employed as operatives with the majority involved in assembly or other types of semi-skilled production work. A demographic breakdown of women operatives showed that 68% were White, 12% Black, 14% Hispanic, and 6% other minority women. In contrast, only 15% of men (13% white/26% minority) in the components industry held these kinds of jobs. For further detail see **Table I-B.**

---

*While we generally consider employment characteristics of the semiconductor segment to be consistent with other electronic components manufacturers, please take note that the data provided in this report are based on large plants (100 or more employees per facility) which constitute less than one-third of all establishments engaged in components manufacture. It is WOW's opinion that these data are representative for purposes of this study.

TABLE I-A.

SELECTED DEMOGRAPHIC CHARACTERISTICS
OF THE
ELECTRONIC COMPONENTS INDUSTRY

1982

	Total Number	Number Women	% Women	% White Women	% Minority Women
Total Employment	557,239	250,799	45.0	32.9	12.1
Total White Collar	306,805	99,741	32.5	26.2	6.3
Officials and managers	68,977	9,064	13.1	11.1	2.0
Professionals	98,373	16,329	16.6	13.8	2.8
Technicians	63,682	16,615	26.1	19.2	6.9
Sales workers	6,976	1,692	24.3	22.3	1.9
Office and clerical workers	68,797	56,041	81.5	66.1	15.3
Total Blue Collar	242,871	149,425	61.5	41.8	19.7
Craft workers	53,053	13,610	25.7	18.0	7.7
Operatives	167,316	119,897	71.7	48.5	23.2
Laborers	22,502	15,918	70.7	49.0	21.8
Service Workers	7,563	1,633	21.6	15.1	6.5

Note: Data covers 560 companies (with 100 or more employees) operating 1,264 manufacturing facilities in the components industry.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

TABLE I-B.

OCCUPATIONAL DISTRIBUTION BY SEX
FOR THE
ELECTRONIC COMPONENTS INDUSTRY

1982

	All Workers % of total	Women Workers % of total	Men Workers % of total
Number	557,239	250,799	306,440
Total	100.0	100.0	100.0
Total White Collar	55.1	39.7	67.6
Officials and managers	12.4	3.6	19.6
Professionals	17.7	6.5	26.8
Technicians	11.4	6.6	15.3
Sales workers	1.3	0.7	1.7
Office and clerical workers	12.3	22.3	4.2
Total Blue Collar	43.6	59.6	30.4
Craft workers	9.5	5.4	12.9
Operatives	30.0	47.9	15.4
Laborers	4.0	6.3	2.1
Service Workers	1.4	0.7	0.2

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983)

Occupations and Outlook

The outlook for employment in the semiconductor industry appears to be generally favorable given a resurgence in the number of firms that are building as the economy improves. The significance of the industry's technology and its far-reaching effects underscore the virtual certainty for continued growth. Employment is anticipated to increase for all job classifications within the industry but the most promising career opportunities will be in high skilled white collar jobs.

Professional and technical occupations include electrical, chemical and mechanical engineers, chemists and physicists, materials scientists, computer scientists, software development engineers and financial professionals. Entry-level job categories for technical personnel range from circuit designer, software engineer, wafer process designer, product engineer, product marketer and reliability and quality assurance engineers to a variety of other specialty jobs associated with semiconductor design, manufacture and sales. Entry level positions generally require a minimum of an undergraduate degree in a related field (e.g. engineering, physics, computer science.)

Production occupations include skilled jobs such as supervisors, inspectors, machine tool operators, machinists, platers, etchers or engravers and order fillers; semi-skilled jobs such as testers and assemblers; and unskilled jobs such as plater helpers and production packagers. Semiconductor manufacturing has been described as the most complex production process ever adapted to mass production. Semiconductor devices are processed in batches and assembly and fabrication involves a significant number of precise operations performed in sequence. In most cases failure in sequence or any minute defect results in discarding the batch. The work can be painstaking and tedious given the complexity of the process, the microscopic characteristics of the components, the demands for precision and other stringent production requirements.

Workers in semi-skilled occupations generally need a high school diploma; coursework in math and electronics is considered desirable. Skilled jobs often require some post-secondary training though semi-skilled workers may gain these through promotion. Transition to white collar status usually involves additional education or vocational training most likely gained through the individual worker's own initiative.

Production jobs are the least secure in the industry because they are more suseptible to market factors (e.g. swings in demand for products) and general economic conditions than higher skilled white collar jobs. Production employment is also characterized by higher turnover rates due to the above in addition to lower wages, working hours (e.g. night shifts), environmental conditions of the workplace and rigid production standards.

As indicated in the previous section, production employment has been predicted by some industry experts to decline proportionally to professional/technical employment though in real terms the number of jobs will continue to grow. Advances in process engineering are moving toward increased automation in the semiconductor industry, which may upgrade some job categories while eliminating some of the routine assembly and fabrication tasks. Given predicted industry growth employers should be encouraged to maintain and upgrade their resident population of production workers (primarily women) to newly developing higher skilled jobs through on-the-job training.

Professional and technical jobs on the other hand are more secure because of "shortages" of workers in these fields. WOW learned of at least one major employer who provides on-the-job training to entry-level personnel through a rotational program -- in this instance for engineers -- where the new employee spends the first year in four different work areas before direct placement occurs. Most employers promote career enhancement through tuition reimbursement programs that encourage workers to upgrade their skills and update their knowledge of technological developments in micro-electronics. We expect that employers will continue to concentrate on recruiting efforts directed at highly skilled workers and that competition among employers may enhance salaries and benefits given current shortages of qualified candidates.

Sales positions with manufacturers and distributors generally require industry/product expertise plus traditional entrepreneurial skills. The number of jobs associated with wholesale distribution is unknown and the number of firms (also undetermined) fluctuates with industry production cycles and product changes. Present indicators suggest a reduction in the proportion of industry sales handled by distributors as semiconductor companies themselves take on more direct marketing functions. [For employment data related to user markets check other sections of this report since the other four industries analyzed are principal purchasers and, in selected instances, producers of these devices.]

Unfortunately we were unable to locate specific employment projections for the semiconductor industry but provide in **Table** I-C on the following page statistics for a few generic occupational categories. We also anticipate the creation of new job categories that will develop as a result of technological advances in the industry.

TABLE I-C.

Employment Projections for Selected Occupations in the Semiconductor Industry*

	Employment (000s) Actual 1982	Moderate Trend 1995	Percent Change
Chemical engineers	44	62	41%
Electrical engineers	320	528	65
Mechanical engineers	209	318	52
Electrical/electronic technicians	366	589	61
Technical sales representatives	1,320	1,707	29
Computer specialists	521	943	81
Electrical/electronic assemblers	286	362	27

*Note: Projections cover employment in all industries.

Source: Silvestri, Lukasiewicz and Einstein, "Occupational Employment Projections Through 1995", Monthly Labor Review (November 1983), Table 1.

General Industry Characteristics

Plant Characteristics

The electronic components industry is highly fragmented compared with other industries. The most recently published statistics indicate that there were about 4,500 facilities engaged in the manufacture of electronic components in 1977. It has been estimated that about 550 of these were semiconductor plants. On the average components plants are small operations -- nearly two-thirds of establishments in the industry group employed fewer than 20 employees.

Although detailed establishment data were not readily available for semiconductor manufacturers, estimates indicate there are about 250-300 companies in the business (with larger corporations

operating 2 or more manufacturing facilities in the U.S.) According to industry analysts the average semiconductor production facility requires about 20 to 50 employees to operate. In selected cases employment may be greater due to the fact that many plants operate in multiple shifts, thereby increasing employment upwards from 50 to 100 workers per facility. It has been estimated that 96% of the value of industry production is derived from plants with 20 or more employees.

Industry Concentration

In 1977 the concentration ratios (based on percent of sales accounted for by individual companies) were 51% and 42% respectively for the four largest firms in components and semiconductor manufacture. According to industry analysts the 42% rate for semiconductor companies is probably the same today. Some analysts argued a few years ago that industry concentration would accelerate as new firms would have difficulty entering the industry because of increasing startup costs and as a consequence major firms would gain larger market shares. Despite high capital requirements, new firms continue to enter these markets and many succeed. One factor that influences entry of new businesses is the rapid pace of technological change in semiconductor technology which can place a creative firm with a new process or product in a favorable market position overnight.

Semiconductor firms are concentrated in selected areas of the country. During the early days of the industry (late 1950s-mid-1960s) companies in the industry were based primarily in mid-Atlantic, southern and New England states. As the western-based military aerospace industry became heavily dependent on semiconductor technology, many small firms developed in that area to capture these markets. Therein was established a technological center that continued to grow even after military markets declined in importance. By 1972 a demonstrable shift had occurred from east to west with California and states in the Southwest increasing their production shares.

Additional factors that led to the development and permanence of initially small firms in California's "Silicon Valley" were the availability of specialized materials and services that had developed during peak aerospace activity, the proximity of educational institutions (Stanford and University of California) engaged in advanced scientific research, and the interaction of a large number of technical professionals interested in the development of the integrated circuit. Although the Silicon Valley continues to represent the hub of the industry and the home for research and development and prototype production, a saturation of local resources (e.g. labor) has led to the development of satellite production facilities in nearby states including Arizona, Texas, Washington and Oregon as well as other parts of California.

Major Corporations

Industry analysts divide producers of semiconductors and related devices into two major categories. These are "captive" manufacturers who produce semiconductors for their own use in other manufacturing operations and not for external markets, and "merchant" producers who produce semiconductor products primarily for sale to outside customers.

Among the more than 200 "merchant " corporations that produce semiconductors, several have emerged as industry leaders. By far the largest company (whose primary business is semiconductors) in terms of overall sales and employment is Texas Instruments, Inc. Other major firms include National Semiconductor Corp., Intel Corp., and Advanced Micro Devices, Inc. **Table I-D** on the following page provides sales and employment data for selected corporations whose primary business is the manufacture of these products. In addition to these firms other electronics firms such as Motorola, Inc. are significant contributors to the semiconductor industry.

Major "captive" manufacturers include International Business Machines Corp., Western Electric, and selected businesses engaged in communications, aerospace and other industries reliant upon semiconductor devices. It has been estimated that companies in this group account for one-third of total U.S. production of semiconductor products.

Major semiconductor firms identified in **Table I-D** are also leaders in the larger group of electronic components manufacturers. Based on corporate sales, Texas Instruments, National Semiconductor and Intel ranked first, third and fourth, respectively among components businesses in 1982 according to Dun & Bradstreet. In addition, among the 70 largest companies in the components group, 16 were primarily engaged in semiconductor manufacture and accounted for about 50% of total sales and employment for the group.

Sales

The value of semiconductor shipments was $12.3 billion in 1982. Industry sales are projected to increase to $16.1 billion by 1984 according to DOC estimates or by 30% over 1982 levels. (When adjusted for inflation industry shipments are forecast to increase in value by 40% over the 1982-84 period.) These growth rates are consistent with industry forecasts provided by the Semiconductor Industry Association (SIA) that predict a compound annual growth rate of 21% through 1986. Most of this increase in sales is attributed to integrated circuits which are expected to account for over 80% of industry sales by 1986. In general, industry earnings and profits were depressed during the recent recession.

TABLE I-D.

MAJOR MANUFACTUERS OF SEMICONDUCTORS AND RELATED DEVICES

1982

Company/Corporate Headquarters	Sales (000s)	Employees (number)
Texas Instruments, Inc. Dallas, Texas	$4,000,000	90,000/ 25,000*
National Semiconductor Corp. Santa Clara, Cal.	980,000	38,000/ 10,000
Intel Corp. Santa Clara, Cal.	855,000	15,900/ 5,700
Advanced Micro Devices Inc. Sunnyvale, Cal.	207,000	9,500/ 1,500
Intersil Inc. Cupertino, Cal.	167,000	4,100/ 2,200
American Microsystems Inc. Santa Clara, Cal.	129,000	3,400/ 1,210
Unitrode Corp. Lexington, Mass.	103,000	2,000/ 250
Monolithic Memories Sunnyvale, Cal.	78,000	2,500/ 800
Siliconix Inc. Santa Clara, Cal.	66,100	2,150/ 1,100

*Employees at headquarters location.

Source: Dun & Bradstreet (1983).

Principal Markets

Proportional sales of semiconductors have shifted among purchasing groups over the past several years. During the early 1970s the computer industry and durable goods producers such as automotive and machine tool manufacturers were the primary buyers of semiconductors. Others included consumer electronics manufacturers and the federal government (primarily for military and space activities.) At present, the primary end-use markets for semiconductors and related devices are the following:

	Markets for Semiconductor Sales (estimated % of sales)
Computer	30-35%
Industrial	20-25
Telecommunications	20
Consumer products	15-20
Government	5-10

The most notable changes have occurred in consumer electronic products consumption, where overall U.S. production has declined due to foreign competition, and in telecommunications which has emerged as a primary user of semiconductor components. It is likely that the computer industry will continue to account for the highest proportion of product sales over the coming years.

Distribution

The majority of semiconductor sales transactions result from direct distribution and marketing by semiconductor companies to original equipment manufacturers including those in the computer, durable goods, consumer electronics, and telecommunications industries as well as the federal government. Large buyers generally negotiate prices with semiconductor manufacturers and often require product and packaging specifications.

Off-the-shelf products are sold either directly to customers or through distributors (about 15-20% of industry sales). Distributors engaged in semiconductor marketing generally serve small and medium-sized equipment manufacturers, provide an inventory for a broad range of new and older devices and also provide replacement parts. These businesses operate in domestic and foreign markets.

Most distributors do not necessarily specialize in semiconductor sales but handle other types of electronic components as well as other equipment. The largest distributor of semiconductors is Avnet Inc. with sales of nearly $1.2 billion last year (semiconductor chips accounted for 73% of these revenues.) Other distributors include Arrow Electronics, Inc. and Pioneer Standard Electronics Inc.

Research and Development Expenditures

Although R & D spending in the semiconductor industry slowed during 1982 compared with earlier years, manufacturers in this group continued to contribute a higher proportion of their sales to R & D than most U.S. manufacturing groups despite lower sales and earnings. R & D spending averaged 7.8% of sales (the average for all industries was 2.4%) and amounted to about $3,500 per employee (based on a composite of 10 major corporations).

Research and development activities are critical to the success of the U.S. semiconductor industry given the intense competition with Japanese producers. The pace of R & D is also important since expansion into new product markets can affect product cycles, affect the value of current product lines and accelerate the obsolesence of manufacturers' inventories. In order to compete successfully American firms need to take the lead in state-of-the-art technology as well as expand plant capacity to enter new markets.

Foreign Trade

The semiconductor industry relies heavily on international markets. According to the Department of Commerce, exports accounted for nearly 40% of product shipments sold in 1982 -- since 1972 exports have grown at a compound annual rate of 23%. On the other side of the trade balance, imports as a percent of new supply (product shipments plus imports) grew to represent 29% of industry shipments or by 28% annually over the past decade.

During 1982 the value of exports reached $3.77 billion while imports rose to $4.13 billion. Imports have grown due to overseas manufacturing activities and increased competition from Japanese manufacturers.

Industry Trends

General Outlook

The short-term prognosis for the semiconductor industry is favorable. Improvements in the general economy have contributed to increased levels of demand for semiconductor devices that exceed presently available supply. Industry analysts indicate supply is not likely to reach demand before late 1985.

The long-term scenario for the industry is less predictable in terms of the magnitude of growth that will occur. It appears certain the industry will continue to increase its production capacity and enter new markets as uses of microelectronic components expand throughout the economy. Success will ultimately be measured, however, by the ability of U.S. manufacturers to improve their market position vis-a-vis Japanese competitors to a point where American firms can exert greater control over the market.

Research and Development

Research and development funds will be directed toward technologies associated with integrated circuit design that will increase the number of transistors and other circuit parts implanted on individual chips and improve fabrication (probably by automating the design process.) Emphasis will be on more custom-designed semiconductors where U.S. companies hold a competitive edge over Japanese firms -- at present these products account for about 25% of industry production and are projected to increase to 50% by 1990.

In addition, the industry has sought to pool its technological resources and counter redundancy in research by engaging in cooperative R & D activities. Forty-five members of the SIA have formed the Semiconductor Research Cooperative (SRC) which will coordinate grants to universities and the Microelectronics and Computer Technology Group (MCC), a non-profit group comprised of semiconductor and computer manufacturers. Inter-industry cooperation has been cited as a primary factor influencing Japanese technological success. A successful cooperative arrangement also has the potential for alleviating R & D cost pressure on smaller firms that are not able to absorb these expenditures as easily as larger, more diversified corporations.

Capital Expenditures

Frequent changes in industry technology often require equipment replacement. As industry process techniques become more sophisticated the cost of new equipment rises. Start-up costs for new plants have also become prohibitive for many firms. Capital equipment costs have grown at rates of 15% to 30% per year which are considerably higher than increases in profits with total expenditures nearing $2 billion during 1984. As a result it appears that many firms will have to seek external financing to sustain needed growth.

Again, U.S. firms are behind the Japanese in capital outlays, which were estimated at 15%, versus 25%, of sales based on surveys of leading semiconductor firms in 1982. A few American manufacturers are addressing this gap by making significant investments in expanded capacity -- for example, two industry leaders are increasing their capital spending to enter the latest memory market (256K RAM). These efforts are aimed at recapturing a share of the previous memory market (64K RAM) that was controlled by Japanese manufacturers who accounted for 70% of worldwide shipments.

Industry Structure

Selected firms in the industry have taken a cooperative approach to ease cash flow problems by allowing customers to invest in their business (e.g., IBM recently purchased an interest in Intel). Such arrangements can ultimately lead to acquisitions of troubled firms by major users. The trend toward acquisition began

in the late 1970s and may continue if earnings remain depressed. Another factor that may affect industry concentration is the entry of captive semiconductor producers into merchant markets. It has been estimated that these firms may produce as many as 50% of integrated circuits by 1990.

While current indicators (as those in the past) point toward greater concentration, start-up firms with fresh ideas and new applications/products will continue to enter semiconductor markets and succeed. The customized nature of some products will undoubtedly secure the existence of independent producers though significant shares in the total semiconductor market may be difficult to capture.

Sources of Information About the Industry

"Avnet: The Leading Chip Distributor is Out to Blaze New Trails", Business Week (February 6, 1984), 92-3.

"Capacity is the Only Limit for Chipmakers", BusinessWeek (January 9, 1984), 72-73.

"Electronics - Current Analysis" and "Electronics - Basic Analysis", Standard & Poor's Industry Surveys (1983).

Eckelmann, Robert, "Electronic Components", U.S. Industrial Outlook 1984 Washington, D.C.: U.S. Department of Commerce (1984), 30:1-16.

A Report on the U.S. Semiconductor Industry. Washington, D.C.: U.S. Department of Commerce (September 1979).

The Semiconductor Industry [High Technology Industries: Profiles and Outlooks] Washington, D.C.: U.S. Department of Commerce (April 1983).

SIA Yearbook and Directory. Cupertino, California: Semiconductor Industry Association (annual).

Yasaki, Edward K. "Valley of the Chips", Datamation (September 1982), 169-71.

COMPUTER INDUSTRIES

This profile covers two industry groups -- computer manufacturers and computer services -- on separate bases. The bulk of WOW's analysis is devoted to the larger producer segment in keeping with the emphasis on high tech manufacturing. We recognize, however, the significance of the services sector to employment and therefore provide a brief profile covering the general economic and occupational characteristics of businesses specializing in data processing and computer services. Additional information covering occupations associated with computer use can be found in the **Occupational Profiles** section of the **Working Paper.**

ELECTRONIC COMPUTING MACHINERY INDUSTRY

Industry Overview

The electronic computing equipment (computer) industry is one of the fastest growing segments of the U.S. economy. The value of domestic shipments for the industry exceeded $35 billion in 1982 and worldwide sales for U.S. affiliated companies nearly double that amount. The United States is recognized as the largest producer of computer goods and services in the world.

During 1982 the computer industry had a labor force of about 420,000 workers with women accounting for 37% of all jobs. Although the majority of jobs in the industry are administrative, professional and technical (white collar), two-thirds of women employed by computer manufacturers work in office and clerical positions or semiskilled blue collar jobs. A significant proportion of production work by American-based firms is conducted overseas in Korea, Taiwan and other Asian countries.

The industry is capital intensive based on continual expansion to keep pace with demand for computer equipment and rapid technological change that requires frequent upgrading of processing machinery and equipment. The industry is also labor intensive given its reliance on a highly skilled professional workforce that is responsible for research and development, design of equipment and manufacturing processes, marketing expertise and a host of related activities.

Companies engaged in computer manufacture range from small businesses to international giants like IBM. Consequently plant facilities may require a relatively low number of employees or several hundred workers. The bulk of jobs, however, are provided by major corporations who command the greatest proportion of industry sales.

The general outlook for the industry is one of growth. Current research in computer technology is on the threshold of expanding systems and applications far beyond data processing tasks to fields such as artificial intelligence and robotics. The long-term outlook for U.S. computer manufacturers will depend on their ability to maintain control of both domestic and world markets and maintain a leadership position in computer research and development.

Industry Description

The computer industry is by far the largest of four industries that make up the office and computing machines manufacturing group. Other member industries include manufacturers of calculating and accounting machines, scales and balances, and typewriters and miscellaneous office machines.

Computer manufacturers are classified under SIC 3573 which covers establishments primarily engaged in producing electronic computers which may be used for data processing or incorporated as components of other types of equipment (e.g. industrial control equipment) and systems (e.g. weapons systems). Plants that manufacture peripheral equipment such as storage devices (e.g. magnetic drums and disks), input/output equipment (e.g. card readers and printers), terminals and modems are also covered under the industry definition. Computer manufacturers generally provide general-purpose programs and basic operating systems programs needed to use the computer hardware effectively. In addition, plants that specialize in rebuilding computers are considered part of the industry.

Producers of cash registers, accounting machines, word processors and related "operator-paced" office machines are classified under other industry categories within the larger group. Similarly, plants that primarily manufacture electrical and electronic test equipment, electronic industrial controls, and industrial process instruments are covered by other industry groups.

Facilities that specialize in computer and data processing services are grouped under SIC 737. This category includes businesses that develop computer programs and systems (software), provide key punching services, repair and maintain computer equipment, rent and lease computers, and provide consulting services as well as a variety of other related services. Establishments covered by this group are considered independent from the manufacturing group. Most producers of computing equipment perform many of these services but their internal activities in these areas are usually accounted for statistically under SIC 3573 since their primary business is manufacturing computer equipment. A separate section of this profile is devoted to the computer services sector.

Employment and Earnings

During 1982 manufacturers of electronic computing equipment employed an average of 419,500 workers. Approximately 38% or 157,600 of those employed were production workers. Industry employment grew by about 3.5% during the first ten months of 1983 to 434,500 workers with 167,300 involved in production activities. Although industry employment fluctuated during the recession -- some firms increased employment significantly while other businesses experienced severe financial problems that led to large-scale layoffs -- the general trend has been and will continue to be one of growth in employment.

As the industry has matured, the relative importance of production employment has declined based on three primary factors. The first is the increased dependence of American manufacturers on foreign labor to reduce production costs. According to statistics provided by the Computer and Business Equipment Manufacturers Association (CBEMA), offshore industry employment has increased over the past two decades in real and proportional terms. In 1960, offshore employment represented 18% of total employment but by 1975 the rate had grown to 40% (based on member companies of the association engaged in computer equipment manufacture as well as other manufacturing activities). By 1981 the proportion of foreign to domestic employment stabilized at about 36% for CBEMA members. According to industry analysts, there is a trend toward greater use of overseas manufacturing facilities for computer assembly and production of perhiperal equipment. Most companies have selected overseas locations in the Far East and Southeast Asian countries.

A second factor influencing diminished production employment is technological change occurring within the industry. Advances in computer technology and its applications have led to increased automation in manufacturing processes and techniques. This trend is likely to continue to influence the relative participation rate for assembly and other operative workers. In addition, most new large plants being built are automated, and as a result, will require fewer semi-skilled laborers.

The third factor is the ever-increasing significance of highly skilled personnel engaged in research and development as well as manufacturing and marketing activities in the computer industry. Growth in the number of competing firms in both domestic and foreign markets has made development of new and better computing equipment the dominant component of success. As a result expenditures related to research and development and the requisite personnel needed to conduct this work will continue to grow. In addition, gains in productivity and expansion of production capacity increase the need for systems analysts and production engineers. Innovative and experienced marketing and sales personnel also are considered critical to corporate success.

The Bureau of Labor Statistics recently estimated that employment in the manufacture of computers and peripheral equipment will increase 37% by 1990 or by 62% by 1995 (over 1982) based on a moderate growth scenario. In other words, industry employment would nearly double over the next few years to a labor force of about 700,000 workers.

Average hourly earnings for production workers in the computer manufacturing industry were $7.89 in 1982 with weekly earnings averaging about $327 or $16,350 per year. Production workers were on the job an average of 41.4 hours per week during 1982 with about 2.5 overtime hours. Over the past few months, earnings and hours have increased. In October 1983, the average weekly wage was $367.95 based on 42.1 hours of work. Overtime hours averaged 3.4 per week. Comparable data are not reported for salaried employees.

Demographics of the Workforce

White males constitute the largest group of workers employed by manufacturers of computers and related industry products. Among the 419,500 workers in the industry in 1982, 155,500 or 37% were women. In order to provide further insight into the demographic characteristics of the computer industry we present data (the most detailed available to us) that encompass this industry and other manufacturers included in the larger office and computing machines group. Based on the fact that the computer industry employs the overwhelming majority (85%) of workers in the group we consider these data to be highly representative of the industry under study.

The vast majority of women working in the computer industry are White (80%). Minority women account for only 7% of all industry jobs with these jobs divided evenly among Black, Hispanic, and Asian/Pacific Islander women. The participation rates for non-White males are roughly identical to those of their female counterparts.

Although women hold nearly 40% of industry jobs they are most likely to be employed in the same positions as women in other high tech industries, i.e. women hold nearly 82% of all clerical and office jobs, two-thirds of operative positions, and about one-half of laborers jobs.

Among higher-skilled white collar jobs, women account for nearly 22% of professional positions, 15% of technicians jobs and about 13% of official or managerial positions. Women also represent 18% of the industry's sales workers. The participation rates for minority women in each of these categories is below 3%. **Table II-A** provides additional demographic statistics.

The vast majority of jobs in the computer industry are white-collar (71%) which reflects the significance of a high-skilled labor force. During 1982, one of every two workers in the

TABLE II-A.

SELECTED DEMOGRAPHIC CHARACTERISTICS
OF THE
OFFICE AND COMPUTING MACHINES INDUSTRY

1982

	Total Number	Number Women	% Women	% White Women	% Minority Women
Total Employment	312,031	116,695	37.4	30.2	7.2
Total White Collar	220,987	68,095	30.8	26.6	4.2
Officials and managers	43,302	5,509	12.7	11.3	1.4
Professionals	74,581	16,008	21.5	18.8	2.7
Technicians	49,086	7,487	15.3	12.5	2.8
Sales workers	7,930	1,456	18.4	16.7	1.7
Office and clerical workers	46,088	37,637	81.7	70.6	11.0
Total Blue Collar	87,756	47,854	54.5	39.5	15.0
Craft workers	16,960	3,827	22.6	18.1	4.5
Operatives	63,523	40,495	63.7	46.2	17.6
Laborers	7,273	3,532	48.6	31.4	17.1
Service Workers	3,288	744	22.6	18.9	3.7

Note: Data covers 204companies with 100 or more employees operating 691 establishments in the office and computing machines industry.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

industry held professional, technician, or management positions. An analysis of occupational distribution data for women as a group indicates that only one of every four women held these types of jobs while 2 of every 3 women worked as clericals or operatives. In contrast, over 70% of men in the industry held higher skilled white collar jobs and only 16% were employed as operatives or office workers. **Table II-B** presents these and related data for women and men in the industry.

Occupations and Outlook

Employment prospects in computer manufacturing will continue to be excellent based on the industry's rapid growth and expansion. The demand for workers in most occupational fields in the industry -- especially highly-skilled personnel -- has increased at a greater rate than the available supply of qualified professionals and technicians, thereby placing those meeting employer requirements in favorable positions.

Computer manufacturers employ many types of engineers, scientists, sales representatives, customer service engineers, technicians, craft and assembly workers. Manufacturers also employ a significant number of persons with computer science skills such as systems analysts, programmers, computer operators and keypunchers. Opportunities also exist for other traditional types of employment associated with general business and manufacturing.

Given the importance of technological advance to the industry, major computer manufacturers support a significant amount of research in physics, chemistry, mathematics and related sciences. Scientists and engineers are also needed to develop better techniques, materials and equipment for computers and related devices.

Applied researchers provide concepts that development engineers design into specific products. Research and development activities require specialists in areas such as component and circuit design, communications, equipment design and microelectronic research. Production and quality assurance engineers are involved in developing production techniques, designing production equipment, developing testing equipment and procedures, and designing housings for equipment. Technicians, engineering aides and draftspersons provide support to engineers by handling detailed tasks such as testing, building experimental circuits and collecting data. As the industry becomes more automated the opportunities for those employed in drafting will decline while jobs for CAD/CAM specialists will increase.

As indicated in the previous section on employment and earnings, production jobs will not grow as fast as other types of employment because of assembly work done in overseas plants and increased automation in the manufacturing process. Some industry analysts believe growth in the computer industry will continue to require a significant proportion of production-line workers.

TABLE II-B.

OCCUPATIONAL DISTRIBUTION BY SEX
FOR THE
OFFICE AND COMPUTING MACHINERY INDUSTRY

1982

	All Workers % of total	Women Workers % of total	Men Workers % of total
Number	312,031	116,695	195,336
Total	100.0	100.0	100.0
Total White Collar	70.8	58.4	78.3
Officials and managers	13.9	4.7	19.4
Professionals	23.9	13.7	30.0
Technicians	15.7	6.4	21.3
Sales workers	2.5	1.3	3.4
Office and clerical workers	14.8	32.3	4.3
Total Blue Collar	28.1	41.0	20.4
Craft workers	5.4	3.3	6.7
Operatives	20.4	34.7	11.8
Laborers	2.3	3.0	1.9
Service Workers	1.1	0.6	1.3

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

Although the overall number of workers in semi-skilled and unskilled blue collar jobs may grow, disruptions may affect many workers in these kinds of jobs. When markets are down or businesses fail, layoffs occur. Although existing firms or new companies may balance the scale, unless they are located near shutdown plants they will not absorb those displaced workers. Another problem for production workers is a trend toward the hiring of (temporary) workers on a contract basis -- meaning lower wages and no benefits.

Marketing and sales personnel are critical to individual corporations in the computer industry because of its intense competitive nature. Company sales representatives must be well trained in both marketing techniques and computer applications. Assignments associated with these jobs often extend beyond the sale of products or systems -- in many instances sales reps may perform the role of management or administrative consultant by helping a purchaser reorganize an office or establish a network of computers throughout various kinds of divisions of an organization. Many marketing personnel specialize in a particular type of business and need to understand the internal and external characteristics of a company from both functional and management perspectives. Other sales representatives specialize in engineering or scientific applications. Technical background is generally required for these positions so that the sales representative can understand the customer's needs and recommend appropriate equipment to handle the tasks.

Most computer sales representatives are college graduates and/or persons experienced in sales in related technical or management fields. Major computer manufacturers provide extensive training to entry level sales personnel followed by on-the-job training with senior or supervisory marketing staff.

Once computers are sold, they are installed and then serviced periodically by maintenance or "field" engineers. Field engineers generally work with large-scale computers or systems and after completing company-provided training, are assigned to customers' offices to work under the guidance of experienced field engineers or other specialists. These positions require a variety of skills including a good theoretical knowledge of electricity and electronics as well as mechanical interest and aptitude. Company-provided training is often supplemented by continuing education programs designed to keep the field engineer up to date with current computer technology.

Computer specialists are obviously an integral component of the computer industry's workforce because they are responsible for putting the equipment to work. The increase in the importance of the software and services market has resulted in significant demand for professionals in the field. Given the importance of these jobs to the computer industry as well as other industries that employ computer specialists we have prepared a separate profile devoted to these occupations.

General Industry Characteristics

Plant Characteristics

Manufacturing facilities in the computer industry are extremely diverse in terms of employment. The most recent Census of Manufacturers survey of U.S. industries found 932 establishments specializing in computer manufacture in 1977. Although slightly more than one-half of these plants employed fewer than 20 workers, the average number of persons employed per plant (industry employment divided by number of establishments) was about 250. The involvement of a great number of small firms as well as industry giants accounts for this wide range in plant size. The number of companies classified under SIC 3573 was 808, which indicates that the majority of firms operated only one plant in 1977.

More recent data limited to companies with 100 or more employees in the larger group -- office and computing machinery combined -- showed employment per facility averaging about 450 workers in 1982. Among this group that consists primarily of computer manufacturers, individual companies operated an average of 3.4 plants. Low-end products (e.g. home computers) can literally be manufactured in someone's garage and as a result do not require large labor forces or plant facilities. In contrast, IBM, the industry leader, operates manufacturing facilities that employ thousands of workers.

Industry Concentration

Given the dramatic changes that have occurred in this industry during recent years, it is unfortunate that more recent comprehensive industry statistics covering plants and companies are not available. It appears that the overall number of corporations has diminished since the late 1970s. Standard & Poor's Industry Directory (1983) lists about 500 companies under SIC 3573. While part of the decline can be attributed to business failure, most of the reduction in the number of companies is probably the result of the acquisition of smaller or specialized firms by large corporations. Even though new start-up firms continue to enter the field the trend toward fewer firms will most likely continue.

During the period 1972-1977 concentration ratios for manufacturers of electronic computing equipment declined slightly due to the success of new companies entering the business during that period. Data for 1977 showed the four largest companies accounting for 44% of the value of industry shipments (sales), the 20 largest with 71% and the 50 largest with 85% of sales. In other words, the remaining 758 companies (93% of all firms) as a group accounted for only 15% of total industry shipments valued at $6.5 billion that year or about $1.3 million each.

Events associated with the growth and development of the computer industry over the past few years point toward greater concentration among major corporations in the industry. The advantages associated with size (in terms of overall sales and hence, financial resources) and diversification among product lines (horizontal integration) have sharpened the competitive edge for industry giants. Although the market for computers will continue to expand (which might be construed as a hopeful sign for new entrants into the industry), other factors such as trends toward integrated systems, increased foreign participation in domestic markets and the need for U.S. manufacturers to continue to excel in international markets will probably tip the scale in favor of larger corporations.

Computer manufacturing facilities can be found in most areas of the country. In general, however, computer plants tend to be clustered in selected states, though not to the same degree that other high tech industries are concentrated (e.g. the semiconductor or guided missiles and space vehicles industries). It is not surprising that the greatest proportion of industry sales are generated by plants located in California (30% in 1978). Three other states that were major employers that year were Massachusetts, New York and Minnesota. During recent years some industry analysts anticipated (and local jurisdictions hoped) that computer firms would locate in declining manufacturing areas which had readily available labor forces. This has not become a major trend, however, as corporations have selected plant locations based on other criteria and have tended to move away from the Northeast and Midwest to Western and Southwestern states.

Major Corporations

One company -- International Business Machines Corporations (IBM) -- dominates the computer industry both in the U.S. and abroad. This individual company is the leader in almost all market (product) categories associated with the industry and has worldwide sales that dwarf all other U.S. firms in the industry -- in 1981 IBM accounted for 44% of worldwide computer sales (estimated at $58.5 billion) when compared with other major U.S. manufacturers.

The fast competitive pace associated with this industry results in continual changes in rank among other industry leaders. As a result, the relative positions depicted in the following paragraphs may have shifted since the data were prepared.

Table II-C identifies major corporations whose primary business is computer equipment manufacture. In addition there are other companies that make significant contributions to computer sales but whose primary source of revenues are derived from other products and services. These companies include Hewlett-Packard, Xerox, ITT, Texas Instruments, Tandy and many other well-known manufacturers.

TABLE II-C.

MAJOR MANUFACTURERS OF COMPUTING EQUIPMENT

1982

Company/Corporate Headquarters	Corporate Sales (millions)	Employees (number)
International Business Machines Corp. Armonk, New York	$ 26,200	341,000
Sperry Corp. New York, New York	5,300	92,000
Honeywell Inc. Minneapolis, Minn.	4,920	97,200
NCR Corp. Dayton, Ohio	3,300	68,000
Burroughs Corp. Detroit, Michigan	2,850	57,300
Control Data Corp. Minneapolis, Minn.	2,800	57,000
Digital Equipment Corp. Maynard, Mass.	2,300	60,000
Data General Corp. Westboro, Mass.	654	14,300
Storage Technology Corp. Louisville, Colo.	603	11,500
Wang Laboratories Lowell, Mass.	543	14,000
Amdahl Corp. Sunnyvale, Cal.	394	3,650
Datapoint Corp. San Antonio, Texas	318	5,930
Apple Computer Inc. Cupertino, Cal.	401 (1981)	N.A.

Source: Dun & Bradstreet (1983).

Sales

During 1982 the value of U.S. industry shipments for computing equipment reached $35 billion. Industry sales have been projected to increase to $48.4 billion by 1984 according to Department of Commerce estimates, or by 35% over 1982 levels.

Worldwide sales of computers accounted for by U.S. corporations are approximately twice as great as domestic sales. During 1981 American-based firms reported computer revenues totalling nearly $60 billion. **Table II-D** shows the distribution of sales among these firms. The overall worldwide growth rate between 1980 and 1981 was 20% for U.S. producers.

Industry Products

Discussions of the computer industry generally focus on major product groups such as mainframes, minicomputers (minis), microcomputers (micros), peripherals and software/services. The differentiation among computer hardware product categories is primarily based on data processing capability and cost.* Desktops/personal computers (PCs) and home computers are part of the microcomputer category.

In terms of dollars (not units), sales of computer products on a worldwide basis are distributed as follows:

Table II-E.

Distribution of Computer-Related Sales Based on Worldwide Production by Major U.S. Corporations

	1976 (estimated)	1986 (projected)
Mainframes	26 %	23 %
Minis	9	21
Micros	-	3
Peripherals	43	17
Software/services	22	36
Totals	100 %	100 %

Source: Datamation [As presented in The Computer Industry (High Technology Industries: Profiles and Outlooks), U.S. Department of Commerce, April 1983, Table 1, p. 15.]

* Technological changes are blurring these distinctions among the traditional product groups -- tomorrow's micro may rival yesterday's mini in terms of computing power -- and as a result a new nomenclature may eventually develop for computer products.

TABLE II-D.

DISTRIBUTION OF WORLDWIDE COMPUTER REVENUES BY LEADING U.S. CORPORATIONS*

1981

Company	Sales (%)	Company	Sales (%)
IBM	43.7	Data General	1.4
Digital	6.4	General Electric	1.2
NCR	5.4	Texas Instruments	1.2
Control Data	5.2	Computer Science	1.1
Sperry	5.0	ADP	1.1
Burroughs	4.8	ITT	0.9
Honeywell	3.2	Amdahl	0.7
Hewlett Packard	3.1	Tandy	0.7
Xerox	1.7	Apple	0.7
Storage Technology	1.6	Wang	0.7
TRW	1.5	Total	100.0**

*Limited to U.S.affiliated production; includes software and services.
**Based on total sales of $58.5 billion.

Source: Datamation [As presented in The Computer Industry (High Technology Industries: Profiles and Outlooks), U.S. Department of Commerce, April 1983, Table 2, p. 17.

As **Table II-E** shows, dramatic shifts are occurring in selected product groups. Although mainframes continue to represent a significant share (due to their extremely high cost and the advent of multimillion dollar "supercomputers"), smaller versions of larger computers (minis) will continue to capture a larger portion of the traditional mainframe market.

The invention of the microprocessor accompanied by the rapid acceptance and demand for personal computers will lead to increased market shares for this product group. It is our opinion that the 3% share for micros is a very conservative estimate -- between 1980 and 1981 sales of these products increased over 50%. Software sales are also experiencing an upward trend as hardware prices decline and demand for "user friendly" and specialized programs grow with increased computer usage.

A Datamation survey based on 1981 data showed worldwide sales for major U.S. firms as follows: mainframes, $17.2 billion; minis, $8.8 billion; software and services, $16 billion (estimated); peripherals, $13.8 billion; and, micros, $1.4 billion.

The largest **mainframe** manufacturer is IBM, who accounted for 70% of product sales in 1981. Other producers include Burroughs, Honeywell, Sperry, NCR and Control Data. The two largest **mini** producers in that year were IBM and Digital Equipment followed by Burroughs, Data General, Hewlett-Packard and Texas Instruments.

Many manufacturers of **micros** are well known to consumers based upon their involvement in the home computer market. During 1981 Apple led the pack with 29% of worldwide sales followed by Tandy (Radio Shack) with 21% and Hewlett-Packard with 17%. Other major micro producers were Commodore, Gould, Cado Systems and Cromemco. This particular market is the most dramatic and volatile in the industry. The recent entrance of IBM and the planned participation of other major computer firms into the "PC" market has led to speculation about a "shakeout" in the industry that will eventually spell failure for smaller, less diversified manufacturers as well as a realignment of market shares among industry leaders. An estimated 150 companies compete in the PC market.

IBM also accounted for the largest share (36%) of sales in **peripheral equipment** during 1981. Other major manufacturers of peripherals are Control Data, Sperry, NCR, Storage Technology and Xerox among others. [Information covering companies in software/services market is provided under **Computer and Data Processing Services Industry** profile.]

Another group of manufacturers are plug-compatible manufacturers (PCMs). PCMs compete primarily with IBM in the mainframe market. These companies make computers and peripherals that function as part of an IBM system and use that company's software. These firms compete with lower prices and attempt to accommodate buyers experiencing delays in IBM delivery schedules. Amdahl and National Semiconductor are major PCMs.

Another market area that is characteristic of the industry represents a distribution function called original equipment manufacture (OEM). This term refers to businesses that purchase components such as central processing units and incorporate them into new products by adding additional components (e.g. industrial controls) or software and resell the finished product to the end-user. Another example would be purchasing a peripheral device such as a disk drive, changing the manufacturer's label and selling it as part of a computer system with the OEM's name. This activity is significant in the computer industry since many manufacturers do not produce all of the components in the systems they sell. As a result any company can serve as an OEM.

Principal Markets

Computers are sold to every kind of business as well as to an increasing number of individuals. In recent years, the principal markets for computers, however, have been concentrated in four major industry divisions: services; manufacturing; wholesale and retail trade; and, finance, insurance and real estate.

Since 1970 the use of computers (and employment of computer personnel) has increased rapidly in the services sector with the introduction of more affordable equipment. Early users of computers in the services group such as colleges and universities, accounting and auditing firms and computer programming services have increased their purchases. The greatest increase in sales for services has been hospitals and other health services as well as miscellaneous business services such as firms providing business management services, specialists in commercial research and development, and private employment agencies.

The wholesale trade sector is an obvious market for computers, where they are used to control inventory and shipping. Similarly, retailers have purchased computers to handle inventory and business records and many chain operations have invested in point-of-sale terminals that are linked to central computers.

Computer usage has also increased in traditional user markets that handle large volumes of data such as the insurance industry. Federal agencies such as the Postal Service and state and local governments also have expanded their involvement in computer use for the same reasons. Basically, any organization that collects and manipulates enormous amounts of data -- from airlines to telephone companies -- utilize computerized equipment.

Distribution

Finished computer products are sold through a variety of distribution mechanisms which vary by product line. Expensive equipment such as mainframes are sold directly by the manufacturer to the purchaser. Similarly, mini sales are generally handled by direct-sales personnel to either end-users or original equipment manufacturers. Most major computer firms maintain large sales and marketing departments staffed with technical sales personnel.

The majority of small business computers and high-end desktops (PCs) are marketed by manufacturers' sales personnel to organizations expected to purchase several computers. Wholesale distributors generally participate in the resale of low-end (less expensive) products covering a broad range of the industry's products. Distributors also act as resellers for foreign manufacturers.

Home computers and PCs marketed to individual customers are sold through a variety of competing retail sales outlets. These include specialty (computer) retailers, mass merchandisers, office equipment dealers, mail order operations and computer systems houses as well as company-owned stores.

A recent survey conducted by Future Computing Inc. and reported in Businessweek indicated there are about 2,500 retail stores specializing in computer sales. These include specialty chains (e.g. ComputerLand), manufacturer-owned stores (e.g. Radio Shack, Control Data, IBM and Xerox) and single specialty stores. Recent changes in the retail market indicate that chain stores (those with more than one location) will grow at the expense of specialty stores with a single location. As of June 1983, about one-half of all retail stores were chain operations, one-quarter were single stores and the remaining quarter were manufacturer-owned stores.

In addition about 2,000 mass merchandisers (e.g. Sears Roebuck) have entered the retail market for lower-priced home computers (under $1,000). These firms compete directly with the specialty stores and may affect the viability of those retailers in the future. In response to this trend, many independent computer stores are beginning to concentrate on selling more expensive PCs ($2,000+). Another approach to retail sales is the establishment of computer marts which centralize competing vendors. Several cities including Boston, New York, Dallas and San Francisco are building centers where computer companies can lease space to sell their products.

Research and Development Expenditures

In its June 1983 "R & D Scoreboard", Business Week reported that 25 major computer companies spent $4.7 billion for research and development activities in 1982. This represented a 23% increase over 1981 spending levels despite the recession. IBM alone spent over $2 billion (a 27% increase for the company over the previous year) followed by Hewlett-Packard, Sperry, Honeywell, Digital Equipment, NCR, Burroughs and Control Data whose R & D spending ranged between $220-425 million each.

The above data confirm the fierce competition within the industry and its dependence upon the development of more sophisticated and marketable products. For the group as a whole, these expenditures amounted to nearly 75% of profits during 1982, or $5,112 per employee.

In addition, a Business Week composite of 59 companies specializing in computer peripherals and services also demonstrated significant attention toward R & D activities. During 1982 this group's research and development expenses grew 33% over the 1981 level and exceeded collective profits by nearly 30%. Average R & D dollars per employee were $4,340. Storage Technology, a major manufacturer of peripherals, was the leader by accounting for 17% of the group's total expenditures.

Trade

International sales are a significant factor in the health and growth of the U.S. computer industry. The United States is a major exporter of computer products and the trade surplus for the industry remains strong despite recent setbacks for selected firms operating in European and Japanese markets. Exports of computer products were valued at $9 billion during 1982 with the United Kingdom, Canada, West Germany, France and Japan representing the major destinations for these goods.

Imports totalled nearly $2.3 billion in 1982 with Japan contributing 34% (an increase of 88% over the previous year) of the total followed by Canada, Hong Kong, Mexico and the UK. Although the trade balance remains strong, a gradual erosion of the differential between imports and exports is a major cause of concern to the industry and U.S. trade specialists concerned with broader policy implications. Between 1981 and 1982 exports increased only 4.5% while imports grew 30%.

Industry Trends

General Outlook

At the outset it is important to remember that American firms dominate world markets and most likely will continue to do so for many years. The industry has become a significant contributor to the U.S. economy and has established few frontiers as we enter the information age. According to industry experts, continued industry success is contingent upon a variety of factors including the development of new and enhanced technologies that incorporate advances in other scientific fields and the incorporation of advanced capabilities into progressive systems that broaden the range of computer applications -- that is, to develop systems that go beyond data processing or information management (e.g. artificial intelligence and automation).

Industry success will also depend on the industry's ability to compete with other nations at home and abroad. Major factors in this context are the ability of U.S. producers to meet unprecedented price competition across all product lines in both foreign and domestic markets, to capture new foreign markets (e.g. developing countries), and maintain leadership in the software and services segment where the greatest share of revenues are derived.

Products

The introduction of new products and the improvement of existing computer equipment are expected to continue at breakneck speeds in the years to come. Rather than discuss today's and tomorrow's numerous product lines we refer readers to the many authors and publishers who specialize in forecasting market trends. This kind of information is reported regularly in business periodicals as well as in a variety of trade publications available at newsstands and bookstores in most parts of the country.

One general trend worth noting is the anticipated growth in communications equipment and software designed to link discrete computers into systems or networks. Systems development has become increasingly important as more offices become automated and desktop equipment becomes more commonplace. Although many manufacturers already market systems, end-users frequently already own or need other equipment that is not part of a company's product line. As a result, many organizations have difficulty linking all components together. Manufacturers will have to be creative in their approach to sales in this area since competing can be difficult where a user business has already invested in another firm's equipment.

The introduction of PCs into the office has also influenced markets for other types of office equipment since many desktop computers perform word processing, computational functions, and other tasks previously handled by separate kinds of equipment. In response, many companies making computer terminals and word processing equipment are adding personal computer features to their products.

Research and Development

It is anticipated that major companies in the computer industry will continue to invest a significant proportion of their earnings in the research and development of new, better and cheaper products. The vast majority of dollars spent on R & D will be devoted to individual corporate endeavors as competition remains keen within the American group and among foreign manufacturers.

A major departure from the isolated approach to R & D occurred last year with the establishment of the Microelectronics & Computer Technology Corporation (MCC) in Austin, Texas. MCC is a consortium of twelve major companies (including Honeywell, Digital Equipment and Control Data) in the computer and related industries who will collectively contribute about $75 million annually as well as loan scientists and researchers to conduct long-term research. This venture was created to counteract the technological success of Japan's MITI. Projects of the magnitude conceived by the founders of the MCC are beyond the scope of most individual corporations.

At the outset, MCC plans four major projects: "Alpha-Omega" - studies of artificial intelligence, new computer designs and database models and structures; CAD/CAM--development of computer-aided design and manufacturing tools to produce very large-scale integrated (VLSI) chips; software--development of programs for Alpha-Omega hardware; and, chip packaging--research to improve housings for VLSI circuits.

Another trend in R & D is the "company-within-a-company" concept. As industry analysts have observed, many of the most innovative research and design in computer technology has come from "start-up" firms. In many instances these new businesses have been established by former employeers of major computer manufacturers who had ideas that did not conform to management's research and development objectives and therefore had little or no opportunity to develop experimental projects. As a result, many corporations are experimenting with the concept of establishing smaller working groups that are allowed to operate "independently" with the hope that this approach will increase innovation, keep experts in-house and potentially encourage more productivity in the firm's R & D efforts.

Industry Structure

The growth rate of the U.S. computer industry has been accelerated by rapid changes in technology that have caused a quick maturing of the industry. As new and profitable markets have emerged, the industry has experienced both vertical and horizontal integration. While there continues to be room for new entrants into the industry with innovative designs and products, the capital requirements associated with establishing large-scale manufacturing facilities will be beyond the reach of many aspirants (especially given the trend toward costly automation in computer plants). Successful new ventures will probably be firms who develop highly specialized products aimed at specific end-users and companies that develop computer software that require lower capital outlays.

Once the dust has settled in newly established markets (e.g. PCs), greater concentration will probably occur as industry leaders secure firmer market shares. It appears that those corporations with the greatest assets will continue to diversify their operations either by expanding their manufacturing activities to cover a broader range of products and services or acquire smaller, specialized companies. In addition, financial constraints associated with frequent changes in technology and associated capital costs have prompted many smaller firms to enter into joint ventures with larger manufacturers.

COMPUTER AND DATA PROCESSING SERVICES INDUSTRY

The computer and data processing services (computer services) industry represents one of the most dynamic sectors of the computer industry. Although fewer than 1,000 companies specialize in providing these types of services, over 5,000 participate in the computer services market. The following "mini-profile" capsulizes the employment and general economic characteristics of this industry group.

Industry Description

Establishments whose primary activity is the sale of computer and data processing services are combined under SIC 737. This group represents three primary industries including those engaged in the following activities:

- Computer programming and other software services -- SIC 7372
- Data processing services -- SIC 7374
- Miscellaneous computer-related services -- SIC 7379

The first industry (SIC 7372) represents businesses that specialize in providing services in computer programming, systems design and analysis, systems engineering and other computer software. Of the three industries, computer programming and software services is the most dynamic and is expected to grow at a significant pace over the next few years. Demand for these types of services will continue to develop as computer usage becomes more widespread.

The second industry (SIC 7374) covers establishments whose primary business is providing data processing services. These services may consist of complete processing and preparation of reports from data supplied by the customer or may be a specialized service such as key punching or making data processing equipment available to others on a time-sharing basis. Also included in this category are establishments that manage and operate the computer and data processing facilities of others on a continuing basis.

The rate of future growth for the data processing industry will depend on a variety of factors related to computer usage. Particular activities of the industry may eventually erode as and more businesses purchase computers and begin to handle more data processing tasks internally. On other hand, firms specializing in data processing have been adding more advanced applications requiring the expertise, computing power and economies associated

with national and international networks. As a result this industry is expected to grow but at a slower pace than the software/programming segment.

The third industry (SIC 7379) covers establishments that specialize in computer and data processing services not classified under the other two industries. The primary services performed by companies in this group include rental, leasing, and repair and maintenance of computers and related equipment. Computer consultants operating on a fee basis are also covered by this industry. Firms that specialize in finance (equity) leasing or rental and manufacturers that lease or rent their own equipment are excluded from this industry classification.

The miscellaneous computer and data processing services industry may experience constraints in the future based on the outright purchase of computer equipment by business and other organizations as it becomes less costly. Although leasing and rental agreements will continue to be the avenue for users of larger, more powerful mainframes and other expensive computer systems, advances in computer technology that affect the markets for these products will most likely affect those who rent/lease them.

Employment and Earnings

According to the Bureau of Labor Statistics, total employment in the computer services group averaged 357,500 during 1982 with about 80% of workers holding jobs without supervisory status. By October 1983 the industry's labor force reached 412,100 workers, which represented a 12% increase over the previous twelve months. Throughout 1982 and 1983, women accounted for 45-50% of all industry jobs.*

Weekly earnings averaged $320.78 ($8.60 per hour) during 1982 for nonsupervisory personnel based on a 37.3 hour work week. During October 1983 weekly wages rose to $364.98, reflecting an 11% increase over the preceding 12 months while the number of hours remained under 38 per week.

---

*There appears to be a major discrepancy in employment data for SIC 737 covering women based on Bureau of Labor Statistics reports and those issued by the Equal Employment Opportunity Commission. While BLS data show women's participation rates above 45%, EEOC data for the same period that cover 90% of total industry employment show a 35% rate for women. Unfortunately efforts to resolve this difference did not yield meaningful results. As a result we present data from both sources and label them accordingly to avoid confusion.

Demographics of the Workforce

According to data reported to the Equal Employment Opportunity Commission (EEOC) by computer service companies employing 100 or more workers, three-quarters of all personnel held white-collar jobs in 1982. [The following information is based on reports made by 420 companies that employed 322,863 workers in 1,272 separate employment facilities.] Most women (51%) were employed as clerical or office workers. Although one out of every four women were classified as professional (15%) or technicial (10%) workers, only 6% acted as officials or managers. Approximately 10% of women were employed in semi-skilled operative positions.

In contrast to the above, men were more likely to hold higher-skilled and better paying jobs in the industry. Nearly one out of every five men working in computer services establishments held a management position in 1982 and 28% held professional jobs. In addition, roughly 30% of men in the industry were represented in technician (16%) and craft occupations (15%).

Among all workers, women predominated in only one area -- clerical and office work -- where they accounted for 79% of all jobs. Women also held 36% of all operative positions and 40% of unskilled jobs. Among higher-skilled white collar jobs, women represented one-fifth of all professional workers and one-quarter of technicians while accounting for less than 15% of official and management positions.

Total minority representation in the computer services industry was less than 15% during 1982 with men holding about 8% of all jobs and women with less than 7%. The majority of minority women working in this industry were employed in office or blue collar occupations. Very few non-White women held other types of white collar jobs -- this group of women accounted for less than 2% of all management jobs, less than 3% of all professional jobs, and less than 5% of all technician positions.

Occupations and Outlook

Prospects for employment in computer services will continue to be favorable during coming years but most opportunities will be limited to applicants who have already acquired computer skills through educational programs in applicable disciplines and/or training and experience in computer-related fields. The most lucrative positions will be for job seekers with the most advanced computer skills and training.

Major occupations associated with the computer services industry include systems analysts, programmers, computer operators, data entry (keypunch) operators, other peripheral equipment operators and computer service technicians. Employment in all of these occupations is expected to increase significantly over the next decade with the exception of data entry operators whose population is expected to decline as methods of data entry change. **Table II-F** provides projections for these occupations through

Table II-F.

Employment Projections for Selected Occupations in the Computer Services Industry*

	Employment (000s) Actual 1982	Moderate Trend 1995	Percent Change
Computer specialists	521	943	81%
Programmers	266	471	77
Systems analysts	254	471	85
Computer operating personnel	580	737	27
Computer operators	211	371	76
Data entry operators	320	286	(11)
Peripheral EDP equipment operators	49	80	63
Computer service technicians	55	108	97

*Note: Projections cover employment in all industries.

Source: Silvestri, Lukasiewicz, and Einstein, "Occupational Employment Projections Through 1995", Monthly Labor REview (November 1983), Table 1.

1995 based on the potential employment needs of all industries. The following overview of occupations associated with the computer service industry also apply to other industries where computers are used.

Systems analysts are in high demand among computer service as well as other industries. Systems analysts are generally expert programmers who are responsible for collecting facts regarding the information needs of the computer user and analyzing those data in order to develop efficient patterns of information flow from its sources to the computer. In addition, systems analysts define the computer process necessary to turn the raw data into meaningful information and plan the distribution and use of the information.

Although many large firms employ their own computer experts, many seek the assistance of external service organizations who specialize in this field. Computer service firms are often called upon to assist any organization (regardless of size) that

is computerizing its operations. Many systems analysts specialize in specific applications (e.g. engineering, business) and are usually required to have interdisciplinary educational backgrounds that encompass computer science as well as the specific application area (e.g. degrees in engineering, physics, etc.). One of the most challenging areas for the systems analyst is the field of operations research where the analyst has to formulate mathematical models of management problems and use them to provide a quantitative base for making decisions.

Computer programmers are responsible for implementing the design of information processing systems by systems analysts. A programmer devises a detailed plan (program) that consists of a series of instructions which make the computer perform the desired operations. Programming tasks can be tedious depending on the complexity and number of instructions required to accomplish data processing tasks. Programmers generally work in teams with varying levels of responsibility. A large-scale project generally involves the participation of a program manager, senior, staff and junior level programmers, coders and trainees. Programmers often specialize in specific areas such as scientific applications, business applications or systems programming.

Computer operators play a key role in the services industry, especially in firms that specialize in data processing services. Job categories in this group include console operators, tape librarians and handlers, operators of peripheral equipment (e.g. high speed printers, communications units, etc.). Career advancement in this field is generally limited to supervision or management positions in data processing centers though perseverance and continuing education in computer science may aid a transition into the field of programming.

Data entry operators or keypunchers are considered clerical workers. As indicated previously, the demand for this occupation is expected to decline because the use of punched cards, paper tapes and other key-driven data recording devices are being replaced by more advanced input devices.

Additional detail pertaining to computer occupations is provided separately in the **Occupational Profiles** section of the **Working Paper.**

Industry Characteristics and Trends

Introductory Comment

The computer services industry is extremely difficult to characterize because data pertaining to the group vary widely. As we indicated earlier 420 private companies who classified their primary business under SIC 737 filed EEO-1 forms for 1982. According to a report prepared by Pantages Reports for the Association of Data Processing Service Organizations (ADAPSO) there are more than 6,000 computer software and services companies in the U.S. ("Computer Services: Visible Solutions for Management's

'Invisible Demand'"). Part of this discrepancy is definitional. ADAPSO includes all businesses who participate in providing computer and data processing services including those who specialize in other activities (e.g. manufacturing). On the other hand, the EEOC data does not cover smaller firms (those with fewer than 100 employees) and does not include the many new entrants who joined the business since 1982.

For purposes of this profile we've chosen to depart from the industry classification scheme we've adhered to elsewhere in the **Working Paper** to discuss this industry. We consider it more important to characterize the full range of market activities associated with information services for purposes of identifying occupational/employment opportunities. As a result, the following sections pertain to all providers of computer services from one or two-person independents to multi-billion dollar computer manufacturers.

Major Corporations

Computer industry giants control the largest share of revenues associated with information services. In recent years, IBM has maintained the number one slot as a supplier of software products and computer services followed by Control Data, Digital Equipment, NCR and Burroughs. Also operating in the same league are three other firms who specialize in providing information services -- Computer Sciences Corporation (CSC), Automatic Data Processing (ADP) and Electronic Data Systems Corp. (EDS). All of these companies offer a broad range of computer and data processing services.

Sales

According to Input, a California-based research firm, industry sales exceeded $25 billion during 1982. During that year data processing accounted for about one-half of total revenues followed by professional services, software products and integrated systems.

Input has estimated that expenditures for information services will grow 24% per year between 1982 and 1987 which would result in tripling sales by the latter year. During this period market shares are likely to shift in favor of software products and integrated systems.

Services Markets

Analyses of computer services usually concentrate on major service markets such as software products, processing services, professional services and integrated systems. Computer professionals often specialize in one of these areas although transferability of skills allow many industry employees to move among the services groups.

Software products. This particular market is expected to grow the most dramatically over the next few years. Product sales have been estimated at $5 billion for 1983 and are projected to increase 38% annually through 1987. Software products consist primarily of instructions that guide computer equipment through tasks. These products include systems and applications software that are provided by both hardware and software producers. Applications software has become increasingly important as computer usage goes beyond traditional transaction processing activities relegated to data processing departments on to decision-making activities made by managers and professionals.

Growth areas include graphics software and information analysis systems used for budgeting, decision support, financial planning, forecasting and modelling. Users will continue to increase their purchases of industry-specific packages (e.g. banking) as well. Application development tools such as data base management systems, automatic documentation as well as management, spreadsheet and retrieval systems will also be in demand. According to one industry report more hardware manufacturers are beginning to turn to independent firms for their applications software because of high internal programming costs and shortages of qualified programmers in-house.

Major software product suppliers are Management Science America, Informatics and ADP. In addition, smaller firms who specialize in software for microcomputers such as VisiCorp, Softsel, Alpha Micro-Systems and Micropro are growing rapidly.

Processing Services. Revenues associated with the purchase of data processing services will continue to grow based on increased demand although at a slower pace than other market segments. During 1983, sales of these services reached $11 billion and have been projected to grow about 14% per year through 1987. Although the shift to in-house systems (e.g. microcomputers) will influence demand, companies in this market will continue to supply customers who have insufficient internal computer capacity to handle their data processing needs. In addition, the systems and services performed by large processing service firms are often more sophisticated than the capabilities of today's microcomputers. Leading data processing companies include ADP, EDS and Tym-Share.

Many firms specializing in data processing have expanded their services by selling more applications, systems and decision support packages for use on the customer's computer. In addition, many are offering integrated systems and data bases covering information important to business (e.g. economics and energy.) Major multiple service companies include GEISCO, Control Data, United Telecom Computer Group, Comshare, Xerox Computer Services among many others. Recent entrants to the field during 1982 were two industry giants -- IBM and AT&T.

Professional Services. The general increase in computer usage combined with the development of more sophisticated applications will enhance the market for professional services such as custom-made computer systems and programming to perform specialized tasks. During 1982 sales grew to around $5 billion and are expected to increase an average of 21% per year through 1987.

Much of the growth in professional services will address the increased use of microcomputers in office settings. A variety of consulting and training services along with programming and analysis may be required by organizations who wish to link PCs together and/or with diverse computer equipment to form internal computer networks. Services may also be purchased to link internal systems with external data bases and networks. The largest companies in professional services are CSC, EDS and Planning Research Corporation.

Integrated Systems. The market for integrated systems (hardware and software sold as a package with services such as training and consulting) that are designed for specific applications or industries has recently emerged as a distinct market category and is expected to grow at a 29% annual rate through 1987. During 1982 expenditures for these systems (including services) exceeded $3 billion.

"Turnkey" (another term for integrated systems) are used by larger firms with special applications needs (e.g. CAD/CAM) or by small firms who need a complete system they can "turn on" and operate. Major contributors to this market are ComputerVision, Applicon (a subsidiary of Schlumberger) and Gerber Scientific.

One other market worth noting is **on-line data base services.** According to LINK Resources Corp., revenues based on these services were slightly over $1 billion in 1982 and are expected to triple by 1987. Over three-quarters of sales came from business information data bases with professional information services, scientific and technical information and consumer data bases accounting for the remainder.

Despite the involvement of major corporations in the computer and data processing services field, significant opportunities exist for small businesses and even individuals to participate in established markets and new ones that develop. For instance, a significant amount of activity is occurring in the personal computer software market. Although large estabished corporations ranging from book publishers and sellers to financial services corporations are competing for mass markets in publishing and distribution, independent software firms are likely to succeed in developing more sophisticated, higher margin products and multi-functional programs.

Sources of Information About the Industries

Archbold, Pamela, "The Foremost U.S. Companies in the Data Processing Industry", Datamation (June 1982), 115+.

"Can Minicomputers Sustain Their Recovery", Business Week (January 30, 1984), 50-57.

"The Chains Take Over Computer Retailing", Business Week (November 7, 1983), 70-79.

Computer Careers. Washington, D.C.: Computer and Business Equipment Manufacturers Association (no date).

The Computer Industry [High Technology Industries: Profiles and Outlooks] Washington, D.C.: U.S. Department of Commerce (April 1983).

"Computers & Office Equipment -- Current Analysis", Standard & Poor's Industry Surveys (September 22, 1983), C61-64.

"Computer Services: Visible Solutions for Management's 'Invisible Demand'" [Advertising Supplement prepared by Pantages Reports for ADAPSCO] Business Week (1983).

"Computer Shock Hits the Office", Business Week (August 8, 1983), 46-53.

Larson, Erik and Carrie Dolan, "Large Computer Firms Sprout Little Divisions for Good, Fast Work", Wall Street Journal (August 19, 1983), 1 + 17.

Marbach, William D. et al, "The Race to Build a Supercomputer", Business Week (July 4, 1983), 58-64.

"Mass Marketers are Reprogramming the Software Business", Business Week (August 29, 1983), 82-86.

McPhee, John and Tim Miles, "Computing and Office Equipment", U.S. Industrial Outlook 1984. Washington, D.C.: U.S. Department of Commerce (1984), Section 27.

"Personal Computers: And the Winner is IBM", Business Week (October 3, 1983), 76-95.

Soma, John T. The Computer Industry: An Economic-Legal Analysis of its Technology and Growth. Lexington, Mass.: D. C. Heath & Company (date unknown).

Weyr, Thomas, "Battle of the Supercomputers", Working Woman (February 1984), 86-89.

Wiegner, Kathleen K., "Computers", Forbes (January 2, 1984), 180-186.

COMMUNICATION INDUSTRIES

This profile covers three industry groups including two manufacturing industries -- telephone and telegraph equipment and radio and television communication equipment -- and the telephone communication (services) industry. The two equipment industries are the primary suppliers of telecommunications equipment to telephone and other telecommunications service providers.

At the outset of the project criteria were established for selecting high tech industries to study. One of these factors was real growth in employment which is not met by either the telephone equipment or services industry. These industries have been incorporated into our analysis, however, because of the importance of the evolution occuring in communications technology and its impact on the workforce.

At present there is no standard industry classification that encompasses businesses specializing in all forms of telecommunications equipment and/or services and as a result there are no supporting statistics covering employment and other industry characteristics. The profile heading "Communication Industries" is used instead of "Telecommunication Industries" because the majority of products manufactured by companies in the radio and television communication equipment industry are defense-applied electronic communication equipment rather than what is generally classified as telecommunication equipment.

The profile is divided into two major sections -- the first covers communication equipment manufacturers and the second discusses telephone communication (service) providers. Companies involved in radio and television broadcast communication are excluded from the analysis.

COMMUNICATION EQUIPMENT INDUSTRY

Industry Overview

Companies engaged in the manufacture of communication equipment are the primary developers of telecommunication technology. Although the product markets for the two member industries of this group are expanding, the size and structure of the workforce is constantly changing based on the introduction of automated equipment to manufacturing operations and a trend toward increasing white collar employment.

During 1982 employment in communication equipment manufacturing averaged 55,700 workers with women holding nearly 40% of all jobs. The majority of women in the industry group are employed as blue collar factory workers and about one-quarter work in clerical and office occupations. In contrast, 60% of men employed in communication equipment manufacture hold nonclerical white collar jobs.

Major structural changes are occuring in the telephone and telegraph equipment manufacturing segment based on the partial deregulation of markets for these products and the introduction of new high tech equipment. As a consequence, new and established businesses are entering this production field. Dramatic changes are also occuring in the radio and television communication equipment industry with increased activity in telecommunication equipment markets (e.g. satellite and fiber-optic systems, etc.) as well as growth in defense procurement of military electronic equipment and systems.

Industry Description

The communication equipment industry group (SIC 366) consists of two industries -- manufacturers of telephone and telegraph equipment (SIC 3661) and radio and television communication equipment (SIC 3662). These industries are the primary suppliers of equipment used to provide telecommunication services and other types of communication. Vendors of telephone and telecommunication services are classified under separate industry categories.

Manufacturers specializing in telephone and telegraph equipment (T&TE) produce all types of telephone sets as well as equipment used to transmit calls (e.g. wire cables, optical fibers), terminals which transmit information (private branch exchange -- PBX -- systems, teletypewriters), and equipment used to switch calls by connecting terminals and coordinating telecommunications networks from central offices.

Companies producing radio and television communications equipment (RTCE) offer a much broader range of equipment and systems. RTCE includes a variety of high technology products that can be divided into five basic categories. The following identifies some of the products in each group.

- Communications systems and equipment -- fiber-optics systems, radio communication equipment, space satellite communications systems, radio equipment (mobile, CB, amateur), radio paging equipment, facsimile equipment and antennas

- Broadcast, studio and related electronic equipment -- audio and video broadcast equipment, cable and closed circuit television equipment

- Intercommunications systems -- paging systems, intrusion detection, fire detection and prevention systems, traffic control and railway signal equipment

- Search and detection systems and navigation and guidance systems and equipment -- radar and sonar systems and equipment, electronic warfare, missile and space vehicle navigation systems and equipment

- o Miscellaneous electronic systems and equipment -- electronic kits, ultrasonic equipment, particle accelerators, laser systems and a variety of other products that do not fit into the other four categories

Although plants specializing in telecommunications equipment are not treated as a separate group by the federal government, a general definition of the industry has been offered by the Department of Commerce. According to agency industry analysts, the telecommunications equipment industry consists primarily of firms who specialize in either the manufacture of telephone and telegraph equipment or selected radio and television communication equipment (RTCE), specificially mobile radio, fiber optics, facsimile and satellite equipment components. It is estimated that the RTCE telecommunications products account for about 20% of the total value of that industry's shipments.

Employment and Earnings

During 1982 manufacturers of communications equipment employed 555,700 workers including 210,000 women. The near-majority of those employed (47% or 259,000) held production jobs. Disaggregated statistics for the two component industries demonstrated a major difference in terms of general employment characteristics though average annual wages for production workers in the $20,000 range were comparable.

Telephone and Telegraph Equipment

Employment in T&TE averaged 141,800 for 1982 which represented about one-fourth of the total communication equipment workforce. Nearly two-thirds of T&TE workers were employed in production occupations. The participation rate for women workers was 48%. Weekly wages for T&TE production workers averaged $389.47 during 1982 or $9.86 per hour based on a 39.5 hour workweek.

During the twelve month period ending October 1983, employment declined by 3% to 140,000 workers. According to industry analysts, the consolidation of distribution and support centers as well as the closing of less efficient manufacturing plants contributed to the drop in industry employment. It is likely that automation and simpler production techniques for manufacturing electronic switches and components will contribute to further erosion of the production workforce over the next few years though most of this decline is expected to be handled by attrition rather than major layoffs.

Radio and Television Communication Equipment

Employment in RTCE averaged 414,000 in 1982 with a production labor force of 168,100 workers (40% of RTCE employment). During this period women held less than 35% of all RTCE jobs. Production personnel earned slightly less than T&TE employees by taking home $381.92 a week based on a 40.5 hour workweek at $9.34/hour.

Although government statistical sources vary on the actual number of workers in this industry -- from 414,000 to 453,000 in 1982 -- most analysts agree that employment will grow in this industry over the next few years at an annual rate of 3-5%. Hourly earnings are also expected to increase for RTCE workers during 1984 but at a slower rate than recent years -- wages grew an estimated 11% during 1982 and 1983.

Demographics of the Workforce

Data reported to the Equal Employment Opportunity Commission (EEOC) covering T&TE and RTCE manufacturing plants are not disaggregated for the two member industries. For purposes of this study the summary statistics appear relevant though one should keep in mind that the participation rates for production workers in T&TE are significantly higher than those associated with RTCE (65% vs. 41%). These data represent about 70% of all workers employed by the two industries and cover 292 employers operating 694 production facilities.

During 1982 women accounted for 40% of jobs in communication equipment manufacture. Women workers represented the majority of employees engaged in clerical and office positions and blue collar jobs where they predominated in the operative and laborer categories. In terms of better-paying white collar jobs, women held only 10% of all management positions and about 15% of professional, technician and sales jobs. In the craft worker category -- the most lucrative blue collar occupational field -- women accounted for less than 20% of all jobs. **Table III-A** presents these and additional statistics covering workers in the communication equipment industry group.

About three-quarters of women working in communication equipment manufacture in 1982 were White with minority women accounting for less than 10% of all industry jobs. The employment patterns for minority women show greater participation rates in lower-paying/skilled occupations and extremely low representation in non-clerical white collar jobs. Although non-White males accounted for less than 8% of industry jobs, they were more likely to hold higher-skilled, better paying white collar positions such as technician, professional or management jobs than their female counterparts.

An analysis of occupational distribution by sex shows that most women employed by the industry are blue collar workers. Although 40% of all jobs in communications equipment manufacture were white collar (excluding clerical) during 1982, less than 15% of women in the industry held positions as managers, professionals or technicians (combined) compared to nearly 60% of men filling these kinds of jobs. **Table III-B** provides additional detail.

TABLE III-A.

SELECTED DEMOGRAPHIC CHARACTERISTICS
OF THE
COMMUNICATION EQUIPMENT INDUSTRY*

1982

	Total Number	Number Women	% Women	% White Women	% Minority Women
Total Employment	382,819	153,719	40.2	30.9	9.3
Total White Collar	210,301	62,171	29.6	25.8	3.8
Officials and managers	45,730	3,768	10.4	9.2	1.2
Professionals	69,678	10,066	14.1	12.9	1.5
Technicians	40,308	6,684	16.6	13.8	2.8
Sales workers	3,418	505	14.8	13.5	1.2
Office and clerical workers	51,167	40,148	78.5	68.3	10.2
Total Blue Collar	168,005	90,427	53.8	37.6	16.2
Crafts workers	34,920	6,730	19.3	14.6	4.6
Operatives	124,755	78,794	63.2	43.8	19.4
Laborers	8,330	4,903	58.9	40.8	18.0
Service Workers	4,513	1,121	24.8	17.7	7.1

*Data covers 292 employers eoperating 694 manufacturing facilities.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983).

TABLE III-B.

OCCUPATIONAL DISTRIBUTION BY SEX
FOR THE
COMMUNICATION EQUIPMENT INDUSTRY

1982

	All Workers % of Total	Women Workers % of Total	Men Workers % of Total
Number	382,819	153,719	229,100
Total	100.0	100.0	100.0
Total White Collar	54.9	40.5	64.7
Officials and managers	11.9	3.1	17.9
Professionals	18.2	6.6	26.0
Technicians	10.5	4.4	14.7
Sales workers	0.9	0.3	1.3
Office and clerical workers	13.4	26.1	4.8
Total Blue Collar	43.9	58.8	33.9
Craft workers	9.1	4.3	12.3
Operatives	32.6	51.3	20.1
Laborers	2.2	3.2	1.5
Service Workers	1.2	0.7	1.4

Source: EEOC, EEO-1 Report Summary of Nationwide Industries (1983).

Occupations and Outlook

The general outlook for employment in communication equipment manufacturing appears promising given the growing demand for high technology equipment and expanded communication services. As indicated previously, however, employment characteristics vary by industry and as a result employment rates in associated occupations will experience different growth rates, with a few declining due to the installation of automated systems.

Telephone and Telegraph Equipment

The trend towards digital equipment (i.e., expanded use of microprocessors) in the development of telephone and telegraph equipment has led to a demand for highly skilled technical professionals in the industry including electronics engineers and computer specialists. On the other hand, T&TE manufacturers are converting their manufacturing operations to incorporate improvements in automated production processes that will influence employment in production occupations, e.g. assemblers. Consequently, current projections indicate an overall decline in terms of total T&TE industry employment though opportunities will continue to exist for telecommunications experts. Also, the opening up of T&TE markets to all equipment manufacturers will contribute to growth in marketing and sales occupations as companies (domestic and foreign) battle to increase or hold their share of equipment sales.

Radio and Television Communication Equipment

The outlook for employment in radio and television communication equipment is more favorable assuming the continued procurement of electronics equipment by various agencies of the federal government. Those segments of the RTCE industry that produce extremely sophisticated high tech equipment and systems are experiencing rapid growth and have a continuing need for scientific and engineering personnel in research and development. Once the concepts and initial designs for new products are developed a variety of engineering and other specialists are required to construct equipment/systems. Since most of the industry's products are based on the use of microprocessors (computerized components) there is also a strong demand for experienced computer scientists, especially scientific and engineering programmers that design programs that make the equipment operational.

In contrast to the RTCE industry's growing need for highly specialized technical personnel, the demand for production workers is expected to decline. As is the case with other microelectronic manufacturing activities, production processes are becoming more automated, which leads to a decreased demand for semi-skilled plant workers.

Communication equipment manufacture (in terms of overall expansion of market activities) appears to be a high tech sector to scrutinize carefully in the near-term from an occupational stand-

point. While the trade-off in the expansion of markets versus increased automation in production activities leaves a big question mark in terms of overall employment, it seems likely that excellent opportunities will exist in the future for specialists in the telecommunications field. And, given the diversity of equipment applications that are just beginning to emerge it appears to be a field where requisite skills in relevant disciplines will be the entree to a variety of employment options and opportunities.

General Industry Characteristics

Industry Structure

Telephone and Telegraph Equipment

Very few companies have traditionally been involved in the manufacture of telephone and telegraph equipment (T&TE) because of American Telephone and Telegraph's (AT&T) monopoly. During 1977 there were only 208 companies operating 264 separate plants that specialized in T&TE manufacture. One hundred and ten of these plants employed fewer than 20 workers.

Obviously the industry has been extremely concentrated with AT&T's manufacturing arm -- Western Electric -- controlling the majority of industry sales. Despite the fact that 200+ firms participated in T&TE manufacture in 1977, the four largest firms were responsible for 89% of total industry sales. During 1978 one state, Illinois, accounted for the largest proportion of product sales (44%), followed by Texas, Massachusetts, New Jersey and North Carolina, which collectively contributed 25% to the total value of industry shipments. Current analyses of the T&TE industry indicate a shift in industry concentration based on deregulation and the participation of foreign producers.

Western Electric Corporation -- the manufacturing branch of AT&T -- holds the dominant position among producers of telephone equipment manufacturers in both domestic and international markets. The company's role as sole supplier of telephone equipment to the former Bell System (AT&T, its principal telephone subsidiaries and affiliates) as well as many independent telephone companies has in the past cemented its control over the markets for these products. The only other major telephone equipment manufacturer in the U.S. has been GTE whose overall sales were less than 10% of Western Electric's in 1982.

Radio and Television Communication Equipment

Government statistics covering the radio and television communication equipment (RTCE) industry for 1977 showed 1,873 companies operating 2,121 production facilities. The majority of these plants (54%) had workforces of fewer than 20 employees.

Concentration ratios for the RTCE industry were much lower than T&TE which demonstrated the existence of competition among manufacturers. During 1977 the four largest companies accounted for 20% and the 50 largest companies commanded 73% of total industry shipments. California led other states in the production of RTCE during 1978 by manufacturing goods valued at 24% of total shipments. Other major producer states were New York, Texas, Florida and Illinois. These states as a group accounted for an additional 30% of industry shipments.

Concentration rates for specific product segments of the RTCE industry may have tightened somewhat since the last Census of Manufactures reported the above concentration ratios given the spectacular performance of selected high tech firms and the increased capital and labor requirements needed to secure market shares. In general, however, overall concentration rate will probably remain low because of the number and diversity of product lines covered by the industry definition.

As noted previously, corporate participation is more diverse in the RTCE industry. International Telephone & Telegraph (ITT) is the largest (in terms of overall revenues) among domestic producers of RTCE and is considered the largest seller of telecommunications equipment outside the United States. Other principal producers of RTCE include Westinghouse, Raytheon, Motorola and Martin Marietta. A more complete list of major manufacturers who specialize in communication equipment manufacture is provided in **Table III-C.**

When telecommunications equipment from T&TE manufacturers and RTCE producers are combined Western Electric continued to prevail in 1982 as the industry leader. During that year it has been estimated that the AT&T subsidiary held 68% of the market followed by GTE (11%) and ITT (3%). One other firm, Northern Telecom Ltd., a Canadian-based company with production facilities in the United States, accounted for 8% of the domestic market for telecommunications equipment.

Industry Sales and Principal Markets

Telephone and Telegraph Equipment

Manufacturers' shipments of T&TE were valued at $13 billion during 1983. In general, the demand for all kinds of industry products was off during the recession. Several factors contributed to the softening of markets for the industry such as reduced housing starts, high interest rates, and the impending AT&T divestiture. Although major transformations are occuring in telephone services plant and equipment such as the transition to digital switches, general economic conditions associated with the economy during recent years caused many operating companies to postpone modernization plans.

TABLE III-C. MAJOR MANUFACTURERS OF COMMUNICATION EQUIPMENT
1982

Company/Corporate Headquarters	Sales (000s)	Employees (number)
Telephone and Telegraph Equipment		
Western Electric Corp. (AT&T) Pittsburgh, Pa.	12,000,000	177,000
GTE Automatic Electric Inc. Melrose Park, Ill.	1,040,000	15,000
Teletype Corp. Skokie, Ill.	300,000	5,000
ITT Telecommunications Corp. Johnson City, Tenn.	115,000	5,500
Plantronics Inc. San Jose, Cal.	97,900	1,900
TIE/Communications Inc. Shelton, Conn.	60,000	438
Radio and Television Communication Equipment		
International Telephone & Telegraph New York, N. Y.	17,100,000	368,000
Westinghouse Electric Corp. Pittsburgh, Pa.	8,510,000	145,000
Raytheon Co. Lexington, Mass.	5,000,000	78,000
Motorola Inc. Roselle, Ill.	3,090,000	71,500
Martin Marietta Corp. Bethesda, Md.	2,610,000	34,600
Ford Aerospace & Comm. Corp. Detroit, Mich.	2,000,000	17,600
Harris Corp. Melbourne, Fla.	1,300,000	24,100
E-Systems Inc. Dallas, Texas	442,000	10,000
M/A-COM Inc. Burlington, Mass.	322,000	5,690
Sanders Associates Nashua, N. H.	281,000	6,500
Western Gear Corp. Lynwood, Cal.	270,000	3,190
Magnavox Government & Industrial Electronics Fort Wayne, Ind.	197,000	4,550
Watkins-Johnson Palo Alto, California	127,000	2,930

Source: Dun & Bradstreet (1983).

The depressed situation for producers of T&TE is expected to turn around as economic growth resumes. Industry experts assume the trend toward telephone network expansion and upgrading resulting from advances in telecommunications technology will restore markets for T&TE to previous growth rates. In addition, the AT&T reorganization is expected to increase competition for a substantial portion of equipment sales as more companies vie for the once unified market controlled by the Bell System.

During 1984 the following equipment markets are expected to contribute to overall growth for T&TE manufacturers: private branch exchanges ($3.6 billion); interconnect equipment ($2 billion); key telephone systems ($1.8 billion); telephone answering sets ($700 million); business facsimile units ($350 million); and cordless phones ($300 million).

One of the "hottest" markets is PBXs -- the electronic switchboards that form the heart of office networks. Sales of these systems are expected to increase 10% per year through 1990 with annual revenues in the $6-10 billion range by that year. The increased demand for this equipment is based on several factors including the move toward office automation (the use of digital technology in PBX manufacture has led to the development of one integrated system that provides voice and data switching, electronic mail, automatic telephone answering and voice mail, call forwarding, facsimile transmission and a variety of other potential functions) and the upgrading of local telephone systems (PBXs provide easier interface with primary carriers of voice communications and the conversion to digital switching will boost the replacement market for older PBX (analog) systems currently in use).

At present there is a significant amount of competition in the PBX market and many industry observers predict an upcoming shakeout among the 24 companies that produce these products. Major domestic producers include AT&T, Rolm Corp., Mitel Corp., and GTE. In addition, Northern Telecom (Canada) and NEC Corp. (Japan) are considered major competitors. The success of individual corporations will depend on their retention of market share (this makes the introduction of products easier), financial strength (for R&D purposes), integrated production lines and technical alliances with computer makers.

Radio and Television Communication Equipment

Shipments from RTCE producers reached an estimated $34 billion during 1983, which represented a 14% increase over 1982 sales levels. A significant portion of this growth stems from increased expenditures by the federal government for military electronics equipment. At present nearly 20% of the total procurement budget of the U.S. military (about $16 billion) is allocated to purchases of this industry's equipment and systems.

The following table shows the distribution of sales for major product segments.

Table III-D.

Domestic Shipments of the Radio and Television Communication Equipment Industry
1983 Estimates

	Value of Shipments (billions)	% of Product Shipments	% Change (82-83)
Communications systems and equipment	$ 5.8	17%	15%
Broadcast, studio and related electronic equipment	1.7	5	15
Intercommunications systems	1.5	4	12
Search and detection systems and navigation and guidance systems	20.0	58	16
Miscellaneous electronic systems and equipment	3.6	11	-
Other	1.7	9	-
Total	$34.3	100%	14%

Source: Based on statistics provided in the U.S. Industrial Outlook 1984, Chapter 29.

Recent estimates of industry production activity indicate continued growth in RTCE markets over the next several years with about a 10% increase in sales projected for 1984. A major portion of this growth will continue to be accounted for by sales of high technology electronic equipment used for defense purposes. This growing equipment market includes infrared and video systems for guiding "smart" bombs and missiles, satellites for communications, navigation and intelligence gathering, and lasers for rangefinders and target designation systems. According to the Department of Commerce, the Department of Defense plans to increase it annual expenditures for electronic equipment by 18% per year through 1988.

The most dynamic non-military markets for RTCE are in the telecommunications equipment area. One new market area that is slated for growth is cellular radio telephone systems. The introduction of these types of phones will greatly expand the number of users of mobile radio phones through improved technology in switching techniques. Sales are expected to exceed $1 billion by 1988.

Based upon the success in the development of satellite communications systems during recent years, demand has grown to a point where a shortage of desirable satellite orbital positions has resulted. Although the potential for saturation of available locations exists (unless improved circuitry can be developed to increase satellite transmission capacity), the cost advantages and other efficiencies associated with this form of telecommunication should encourage expansion through the end of the decade. Sales of these systems were valued at $1.3 billion in 1983 and are projected to surpass $4 billion by 1988.

Advances in fiber optics technology has also led to growth in the market for these types of systems. Optical fibers are used in place of wire cables to transmit messages electronically and increase capacity and performance as well as reduce costs when compared with traditional copper cables used in telephone transmission. AT&T has already introduced service on the East Coast using optical fiber cables and has implemented a plan to complete a new transatlantic cable by the late 1980s. In addition to the strong demand for this kind of equipment by the telecommunications industry, fiber optics technology is also used in other applications such as computers and military equipment. Recent Department of Commerce estimates indicate the market may grow from $80 million in 1983 to over $300 million by 1988.

Research and Development

During 1983 the T&TE industry spent about $3.1 billion on research and development devoted to technologies that would improve communication by making it more efficient and economical. Approximately 50% of all R&D expenditures were related to software by adding new features to products and equipment or improving outdated programs. In addition, emphasis was placed on microelectronics (including semiconductors), digital switching and transmission, photonics, and digital signal processors.

Although data pertaining to RTCE industry expenditures for R&D were not readily available these are assumed to be significant based on the importance of high tech to manufacturers of these kinds of equipment.

International Trade

Telephone and Telegraph Equipment

During the first seven months of 1983 the U.S. experienced its first trade deficit in T&TE shipments since 1974 based on imports valued at $1,075 million and exports totalling $835 million. The major reason for this trade deficit is the limited access of domestic manufacturers to foreign government-controlled markets combined with partial deregulation of the U.S. market for T&TE equipment that increased competition in domestic markets.

The U.S. exports primarily to destinations in the Far East, the

European community, Latin America and the Middle East. The major importer into the U.S. has been Japan -- during 1983 imports from that country exceeded 40% of the total and were comprised primarily of switching systems and telegraph equipment and parts. Another major source of imports is Canada. Present indicators suggest an opening up of key foreign markets to the U.S. and other exporters in the near future but until this happens it is likely that trade deficits in T&TE will continue to grow.

Radio and Television Communication Equipment

During 1983 the RTCE industry continued to contribute favorably to the balance of trade with a surplus of about $500 million. Overall 1983 was a year of growth as RTCE exports reached $2.5 billion representing a 4% increase over the previous year. Principal exports included radio communications equipment (36% of total exports); radar apparatus (17%); and radio and television broadcast equipment, radio navigation equipment, and alarm and signal systems accounting for 10% each. The major destinations for these goods were Canada, the United Kingdom, Japan, West Germany, Mexico and Saudi Arabia with no single nation purchasing more than 10% of the total value of exports.

The level of imports for 1983 remained unchanged from the previous year at about $2 billion. Major product categories purchased from foreign suppliers were radio apparatus (21% of total imports), cable television equipment (20%), miscellaneous television apparatus (13%) and sound signalling equipment (12%). Japan led foreign suppliers to the U.S. by accounting for 43% of imports of RTCE followed by Mexico (14%), Taiwan (9%), Canada (7%) and Malaysia (5%).

Industry Trends

For the most part the preceding section covering industry characteristics has identified the major trends in industry structure and markets for communication equipment manufacturers. Trends associated with the T&TE industry generally focus on activities of service providers (see following section on the telephone industry) as companies modernize, deregulation takes hold and telecommunications technology moves forward. Another significant and unfortunate trend is the loss of employment due to automation -- although many industry analysts suggest the worst is over it is WOW's opinion workers will continue to be adversely affected by automation in these industries (as well as other employment settings) in the future.

TELEPHONE COMMUNICATION INDUSTRY

Industry Overview

This segment of the communication field is the largest employer of all the industries covered in the **Working Paper.** During 1982 employment in telephone communication services exceeded one million workers with women accounting for about one of every two jobs. The occupational structure and employment levels in telephone services are changing dramatically with the introduction of automated systems. In addition the recent AT&T divestiture has exacerbated the situation by forcing the relocation and displacement of industry employees at all levels.

At present it is difficult to predict the effects of deregulation on the workforce. On one hand the opening up of telephone service markets to competition and the increase in services to include various forms of telecommunication appears promising for those entering the field. It is difficult to forecast, however, the extent to which any employment gains associated with expanded markets will be offset by reduced labor requirements resulting from increased automation.

Industry Description

The two major industries that provide communication services are telephone communication (SIC 481) and telegraph communication (SIC 482). The standard definition for businesses specializing in telephone communication includes establishments that furnish communication by placing the parties in vocal conversation with one another and covers domestic, international marine, mobile and aeronautical services. Businesses engaged in providing paging and telephone answering services are classifed under a separate industry. The telegraph communication industry covers nonvocal communications including the use of radio telegraph, land and marine cable services and wire or radio phones. The focus of this analysis is on the telephone industry since it is a much larger industry in terms of sales, usage and employment.

Given the evolution of telecommunications technology (that incorporates digital computer technology), these industry definitions will probably change in the future as new forms of vocal and nonvocal communications are developed. Companies such as specialized common carriers, domestic satellite companies, interconnection firms and others are not included in these industry statistics.

Employment and Earnings

Providers of telephone services (SIC 481) employed about 1.064 million workers during 1982. Approximately 75% of those employed were nonsupervisory hourly wage earners and nearly 50% of all employees were women. Actual employment is probably greater if one considers new competitor industries such as specialized common carriers, interconnect firms and satellite companies. Employment in these new telecommunications areas (currently estimated at 40,000-50,000 workers) is expected to increase as much as 10% annually while the number of workers in the traditional industry group will probably stabilize given tradeoffs between increased automation and expanded capacity.

Weekly wages averaged $424.27 for nonsupervisory personnel in the telephone industry during 1982 based on hourly rates of $10.66 and a 39.8 hour average workweek. These wage rates, that translate into annual earnings approximating $21,000, are not typical for all workers in the group. Persons employed as switchboard operators, service assistants, operating room instructors and pay-station attendants -- read women -- earned only $9.04 per hour and represented about 20% of all nonsupervisory workers.

Persons employed in line construction occupations such as central office crafts, installation and exchange repair crafts and line, cable and conduit crafts on the other hand were paid $12.35 an hour -- these jobs are traditionally held by men and represent about 35-40% of total nonsupervisory jobs. In addition, weekly earnings for the former operator group at $305.55 were considerably lower than the $526.11 for craft workers based on a shorter work week -- 33.8 hours for switchboard personnel vs. 42.6 for line construction employees. As a result, operators and attendants had average annual earnings of $15,00 compared with $26,000 for crafts personnel.

Demographics of the Workforce

EEOC statistics for telephone service workers basically cover total industry employment. During 1982 ninety-seven employers provided demographic data for 3,666 separate work sites. Women have consistently commanded a high proportion of jobs in the telephone industry -- during 1982 they accounted for 51% of all jobs -- and demonstrate higher participation rates in all job categories (except craft occupations) when compared with other industries covered in the **Working Paper**.

The somewhat improved representation of women in white collar non-clerical jobs is the result of affirmative action programs required by the federal government to remedy past employment discrimination against women in the telephone industry. During 1982 women accounted for 37% of all official and managerial positions, 31% of professional and 26% of technician jobs though they continued to be underrepresented in craft occupations where they held less than 10% of those jobs. These and related statistics can be found in **Table III-E**.

Minority women accounted for slightly more than 12% of telephone industry jobs or about 25% of jobs held by women. In general the proportional representation (along occupational lines) of these women mirrored that of White women in the industry. NonWhite males constituted only 6% of industry employees but were more likely to be managers or craft workers than minority women.

Despite their overall high participation in the telephone industry workforce, most women (nearly 70%) held traditional nonsupervisory clerical or operator positions which constitute about 40% of all jobs. The near-majority (45%) of men in the industry are concentrated in skilled craft positions while 26% serve in management roles (compared to 15% of all women).

It is important to note than the general occupational characteristics and job distribution patterns associated with the telephone industry are changing rapidly as telephone communications processes are improved by new technologies that increase operation efficiency. Unlike previous periods when technical innovation primarily affected lower skilled jobs, developments in call switching, transmission systems and computer technologies have affected a broader range of occupations including many in the crafts category. Throughout past and present transitions in industry technology, women have been and will continue to be extremely vulnerable to technological change. In addition, the deregulation of the industry will promote a shift towards management and marketing jobs because individual companies must now compete for their share of a once captive market.

Occupations and Outlook

The outlook for employment in many traditional occupations associated with the telephone industry is poor as evidenced by the effects of technological change on industry employment and job content. While new kinds of job categories may emerge in the industry, labor experts forecast that the greatest occupational growth will occur in alternative telecommunication service sectors (e.g. satellite communications). Employment in these new industries, however, may require different and higher skill levels and experience than traditional telephone industry jobs.

The ongoing conversion to electronic switching systems (ESS) has increased the capacity and simplified the installation and maintenance of previous call switching devices. The reliability of these new systems has reduced the need for repairs and allows several switching offices to be linked to one control center where remote monitoring and maintenance functions are performed. These changes have not only reduced the labor requirements associated with call switching -- the need for installation, repair and maintenance personnel -- but also altered the skill content of jobs. The use of computerized equipment has increased the technical skills and educational requirements for many ESS-related jobs by calling for knowledge of computer-based systems and programming rather than requiring the mechanical repair skills needed for previous systems.

TABLE III-E.

SELECTED DEMOGRAPHIC CHARACTERISTICS
OF THE
TELEPHONE INDUSTRY*

1982

	Total Number	Number Women	% Women	% White Women	% Minority Women
Total Employment	1,088,119	555,518	51.1	38.8	12.3
Total White Collar	773,192	506,964	65.6	49.8	15.7
Officals and managers	223,136	83,145	37.3	30.6	6.6
Professionals	68,875	21,331	31.0	25.5	5.5
Technicians	24,564	6,444	26.2	21.0	5.2
Sales workers	26,170	14,416	55.1	45.0	10.1
Office and clerical workers	430,447	381,628	88.7	65.6	23.0
Total Blue Collar	307,666	45,472	14.8	11.2	3.6
Craft workers	262,526	22,546	8.6	6.7	1.9
Operatives	40,439	21,330	52.7	38.3	14.4
Laborers	4,701	1,696	36.1	30.8	5.3
Service Workers	7,261	2,982	41.4	27.3	13.8

* Data covers 97 employers operating 3,666 work sites.

Source: EEOC, EEO-1 Report Summary of Nationwide Industries (1983).

TABLE III-F.

OCCUPATIONAL DISTRIBUTION BY SEX
FOR THE
TELEPHONE INDUSTRY

1982

	All Workers % of Total	Women Workers % of Total	Men Workers % of Total
Number	1,088,119	555,518	532,601
Total	100.0	100.0	100.0
Total White Collar	71.1	91.3	50.0
Officials and managers	20.5	15.0	26.3
Professionals	6.3	3.8	8.9
Technicians	2.3	1.2	3.4
Sales workers	2.4	2.6	2.2
Office and clerical workers	39.6	68.7	9.2
Total Blue Collar	28.2	8.2	49.3
Craft workers	24.1	4.1	45.1
Operatives	3.7	3.8	3.6
Laborers	0.4	0.3	0.6
Service Workers	0.7	0.5	0.7

Source: EEOC, EEO-1 Report Summary of Nationwide Industries (1983).

The introduction of new transmission systems such as glass fiber cables has also influenced the number of cable workers in the telephone industry as well as reduced the skills required for transmission craftsworkers -- e.g., optical systems are likely to be pre-engineered so that cable splicing skills are reduced to plugging two connectors together. In addition, the computerization of systems that aid maintenance and testing operations has had a significant impact on transmission workers in terms of reduced labor requirements and skills.

Computerized telephone systems also have reduced the need for central office craftspersons and operators including occupations such as test desk operator (one who tests lines and switching equipment to locate customer-reported problems), toll operator, intercept operator (one who handles disconntected and non-working numbers) and many others. In fact, the introduction of computer technology into the telephone industry has left few job categories untouched since its influence covers the entire spectrum of occupations from clerical workers whose numbers have been reduced through the use of management information systems to central office managers whose operating facilities have been eliminated.

A considerable amount of research related to job displacement and occupational change in the telephone industry has been conducted by several groups including the industry's principal union, the Communications Workers of America (CWA). We refer readers seeking further detail about this topic to organizations like the CWA and the AFL-CIO's Industrial Union Department.

Although in general, the portrait painted above is indeed bleak for the telephone industry it will continue to be a major employer -- remember that the industry has over one million workers -- and new opportunities will undoubtedly emerge. One area industry watchers indicate will grow will be marketing and sales as the AT&T divestiture leads to competition among vendors of telephone and related telecommunications services.

The following table (**Table III-G**) presents the latest Bureau of Labor Statistics projections for selected jobs associated with the telephone industry. You'll notice that our analysis of employment trends in the industry doesn't dovetail with some of the BLS estimates. We can envision some employment growth based on the installation of new systems but we tend to agree with other industry experts that over the long run many traditional occupations associated with the industry will decline.

Table III-G.

Employment Projections for Selected Occupations in the Telephone Industry*

	Employment (000s)		Percent Change
	Actual 1982	Moderate Trend 1995	1982-1995
Technical sales representatives	1,320	1,707	29
Customer service representatives	89	124	39
Telephone operators	318	343	8
Switchboard	172	213	24
Central office	109	87	-20
Directory assistance	38	43	15
Central office repairers	50	49	-2
Cable splicers	48	60	25
Line installers and repairers	127	157	23
Station installers	59	72	21

*Data covers employment in all sectors of the economy.

Source: Silvestri, Lukasiewicz and Einstein, "Occupational Employment Projections Through 1995" Monthly Labor Review (November 1983), Table 1.

General Industry Characteristics

Industry Structure

The AT&T Divestiture

The Consent Decree of 1982 based upon an agreement between the Justice Department and AT&T required the latter to divest itself of its twenty-two wholly-owned operating companies. These companies have been regrouped into seven independent regional operations that will be responsible for their own planning independent of Bell Laboratories and AT&T. The new operating companies must provide local exchange service and equal access to long-distance networks of long distance carriers. They will also offer other telecommunications services including new cellular radio mobile services and printed directories including Yellow Pages. Some plan to market new customer premises equipment to residential and business customers.

AT&T now consists of Bell Laboratories, Western Electric Company, AT&T Communications (long distance lines), AT&T International and AT&T Information Systems. Although the company lost $80 billion in assets through the divestiture it can now enter new business ventures in developing information markets. The new AT&T will continue to operate its nationwide interexchange long distance network. All long distance facilities, including those owned by the newly formed regional operating companies, have become part of AT&T and AT&T Information Systems will retain ownership of customer premises equipment. Access to services of divested local exchange companies are equal to those offered by other long distance carriers (e.g. MCI, GTE Sprint, ITT, SBS and Western Union). In addition, AT&T and its subsidiaries (e.g. Western Electric and Bell Laboratories) must provide manufacturing, research and other support services to the regional operating companies until September 1, 1987.

The split-up of the Bell System has had an enormous impact on employees at all levels. According to company estimates the reorganization of AT&T resulted in the elimination of nearly 63,000 jobs covering workers in all occupational groups. In addition, although the vast majority of employees continue to perform the same jobs at the same work sites, many faced difficult transition resulting from the reorganization during the past two years.

The Telecommunications Network

The U.S. telecommunications network consists of 22,000 telephone switching offices and more than a billion transmission paths that include 6 million trunks, as many specialized service circuits and 88 million loops connecting customers to central offices.

Added on to this core network are other carriers and service providers. These include specialized common carriers who offer long distance voice and data transmission via their own microwave links; value-added carriers who provide packet-switching exchanges connected by leased transmission facilities to offer data communication services to a wide variety of customers; and domestic satellite and international record carriers who own earth stations, satellites, switching and transmission facilities.

All of the above form the telecommunications network that can act as one integrated and compatible master system to provide a significant number of services including voice, image, data and video. Although the telephone industry's move to Integrated Services Digital Network (changing from electromechanical switches to time-division digital switches) has complicated the process, industry observers project that the evolution occuring in telecommunications technology (if planned through the cooperative efforts of all network participants) will lead to an even greater variety of telecommunications applications and uses.

Principal Vendors and Sales

During 1983 revenues associated with traditional telephone and telegraph services reached an estimated $87 billion. The principal beneficiary of these sales was American Telephone & Telegraph whose annual revenues exceed $50 billion. Until this year the Bell System accounted for the overwhelming majority of domestic telephone revenues with independent telephone companies and other carriers accounting for less than 25% of the market. This distribution of sales will change in coming years with the divestiture of Bell's local operating companies and partial deregulation of the market.

Revenues associated with alternative telecommunication services reached about $4 billion last year based on the following estimates provided by the Commerce Department.

Specialized common carriers	$2,100 million
Mobile services	775 million
Interconnect services	525 million
Domestic satellite companies	454 million*
Value-added carriers	320 million
Miscellaneous common carriers	85 million

*Excludes AT&T/GTE Comstar System leased from Comsat.

Table III-H on the following page identifies major U.S. corporations engaged in providing telephone and telecommunications services.

Industry Trends

The structure of the telephone industry is currently undergoing a monumental change based on advances in telecommunications technology and a new, more competitive environment resulting from the breakup of the Bell System and the reorganization of AT&T. In response to these changes the large independent companies, including GTE and Continental Telecom and others, are expanding their operations to include developing markets such as cellular radio, fiber optics, satellite services, digital electronic mail systems and data communications services.

Other types of businesses are also entering the telecommunications arena including various computer, communications and semiconductor firms. Most often these companies are combining their specialized technologies with telecommunications firms through joint ventures. Industry analysts predict that the trend toward combinations of advanced technologies in a highly competitive environment will stimulate consolidation among competing industries.

TABLE III-H.

MAJOR TELECOMMUNICATION SERVICE CORPORATIONS

Major Telephone Companies
American Telephone and Telegraph Co.
GTE Corporation
Continental Telecom
Centel Corporation
United Telephone System, Inc.

Independent Regional Operating Companies
American Information Technologies Corporations (Ameritech)
Bell Atlantic Corporation (BEL)
Bell South Corporation
NYNEX Corporation (NYN)
Pacific Telesis Group (PACTEL)
Southwestern Bell Corporation
U.S. West, Inc. (USW)

Specialized Common Carriers
GTE Sprint Communications Corp.
MCI Communications Corp.
U.S. Transmission Systems, Inc.
Western Union

Value-Added Carriers
Tymnet
GTE Telenet Communications Corp.
Graphnet
IT&T/Domestic Transmission Systems
Uninet

Miscellaneous Common Carriers
Western Telecom
Southern Satellite
Eastern Microwave
United Video
Midwestern Relay

Domestic Satellite Companies
RCA Americom
American Satellite
Western Union Westar
AT&T/GTE Comstar
Satellite Business Systems

International Record Carriers
ITT Worldcom
RCA Globecom
TRT Telecommunications Corp.
Western Union International
FTC Communications Inc.

Another emerging trend is the establishment of private networks among large corporations. Companies such as Citicorp, Merrill Lynch, Westinghouse and Shell Oil are building their own communication facilities. These firms will have the ability to provide their own communication needs as well as sell excess capacity to other customers. In addition many corporations are establishing local area networks (LANs) to connect various data terminals and office equipment within their businesses. (It is estimated that over 6,000 LANs are currently in operation.)

There are a myriad of other trends associated with the development in telecommunications technology that have been identified throughout this profile. The following list of information sources can serve as a reference point for obtaining additional information about communications industries and their activities.

Sources of Information About the Industry

"Culture Shock is Shaking the Bell System", Business Week (September 26, 1983), 112-118.

Dymmel, Michael D., "Technology in Telecommunications: Its Effect on Labor and Skills", Monthly Labor Review (January 1979), 13-19.

Kohl, George, "Changing Competitive and Technology Environments in Telecommunications", Labor and Technology: Union Response to Changing Environments. University Park, Pa.: Pennsylvania State University (date unknown), 53-81.

Pleasants, Arthur L., "Radio and Television Communications Equipment", U.S. Industrial Outlook 1984. Washington, D.C.: U.S. Department of Commerce (1984), Chapter 29.

Sherrid, Pamela, "Telecommunications", Forbes (January 2, 1984), 237-239.

Sullivan, William J., "Telephone and Telegraph Equipment" and "Telephone and Telegraph Services", U.S. Industrial Outlook 1984 (1984), Chapters 28 and 46.

"Telecommunications - Current Analysis", Standard & Poor's Industry Surveys (September 22, 1983), T1-4.

"Telecommunications: Everybody's Favorite Business/The Battle for a Piece of the Action", Business Week (October 11, 1982), 62.70.

"Telecommunications: The Global Battle", Business Week (October 24, 1983), 126-148.

The Telecommunications Industry [High Technology Industries: Profiles and Outlooks] Washington, D.C.: U.S. Department of Commerce (April 1983).

Telecommunications in Transition: The Status of Competition in the Telecommunications Industry [Report by the Subcommittee on Telecommunications, Consumer Protection and Finance of the Committee on Energy and Commerce] Washington, D.C.: U.S. House of Representatives (November 3, 1981).

GUIDED MISSILES AND SPACE VEHICLES INDUSTRY

Industry Overview

The guided missiles and space vehicles (GMSV) industry is characterized by a highly skilled and well paid labor force with the lowest participation rates for women among the high tech industries WOW has studied. In addition, minority representation for both women and men is embarrassingly low.

The GMSV industry is comprised of about 30 major U.S. corporations that are generally involved with other segments of the aerospace industry. Plant facilities are concentrated primarily in California and a few other states, including Washington, Texas and Massachusetts. The industry is both capital and labor intensive based upon the costs and technological sophistication associated with its research, development and manufacturing activities.

Given the magnitude of many industry projects such as the space shuttle and national defense that are funded by major federal appropriations, the industry is subject to dramatic economic changes based on fluctuating Congressionally mandated policies and priorities for the nation. In addition, competition is keen among companies vying for federal contract dollars and is generally limited to a small number of highly specialized firms.

Industry Description

The guided missiles and space vehicles industry (SIC 3761) is one of six manufacturing groups that form the aerospace industry as defined by the Department of Commerce (DOC). The other five industry groups are manufacturers of aircraft, aircraft engines and engine parts, other aircraft equipment, space propulsion units and parts, and other space vehicle equipment.

Production facilities that are part of the GMSV industry are those primarily engaged in the manufacture of complete guided missiles and space vehicles as well as the research, development and services on or for these products. Establishments engaged in the manufacture of space satellites, guidance and other electronic systems, and space vehicle airframes and capsules are classified in other industry groups. Many corporations whose primary business is classified under GMSV, however, also produce these and related goods and services.

Employment and Earnings

During 1982 the aerospace industry employed about 700,000 workers, one-half of whom were production employees. Slightly more than 100,000 of aerospace workers were engaged in guided missile and space vehicle manufacturing. In contrast to the larger group, only 30% of GMSV employees were production workers, reflecting greater participation rates in GMSV for technicians and professionals such as scientists and engineers. Women accounted for fewer than 25% of all GMSV jobs during 1982.

According to recent Department of Commerce estimates covering the aerospace industry, employment levels began to decline during 1982 and are projected to continue this trend during 1983 and 1984. GMSV employment, on the other hand, has experienced growth -- by October 1983 employment reached 115,900 (including 36,500 production workers) -- and is estimated to grow from 5% to 8% per year through 1984.

Recent estimates made by the Bureau of Labor Statistics (BLS) covering the number of jobs in the GMSV industry forecast an increase of 21% to 24% by 1990 and 33% to 42% by 1995 (over 1982 employment levels). Depending upon industry output and general economic trends this could mean an additional 25,000 to 44,000 new jobs in GMSV over the next several years.

The average hourly earnings for production or nonsupervisory workers in GMSV in 1982 were $11.21 with earnings averaging about $460 per week or $24,000 per year. Most production workers were on the job an average of 41 hours per week with three hours of overtime. By October 1983 weekly earnings reached $509.04 based on a 42.1 hour work week.

Estimates of total payroll dollars provided by the Aerospace Industries Association of America (AIA) for the aerospace industry in 1983 were $35.5 billion. In terms of salaries this reflects annual earnings of about $24,000 for production workers and $35,000 for all other workers, or an average yearly salary approximating $30,000 for aerospace employees.

The above data reflect the employment and earnings of workers in private industry. Other major employers in the field of GMSV and aerospace are the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD). During 1982 NASA employed over 21,000 workers. Employment data were not readily available from the Department of Defense (DOD) regarding that agency's space-related programs.

Demographics of the Workforce

According to data provided by the Equal Employment Opportunity Commission, the overwhelming majority -- 115,410 or 78% -- of all workers in SIC 376 (this three-digit industry code covers manufacturers of guided missiles and space vehicles as well as pro-

ducers of GMSV parts and miscellaneous equipment) were men in 1982. Of the male group only 14,549 or 10% were minority workers. Among the 31,823 women in the industry group during the same year about 20% were non-White.

Disaggregated occupational statistics as presented in Table IV-A demonstrate an even more serious and alarming scenario for women in GMSV. Among white collar workers, women represented less than 5% of all officials and managers, 12% of all professionals, 14% of sales workers and 21% of technicians in 1982. The only white collar category where women predominated was the traditional office and clerical group where they represented 77% of workers in those jobs.

Among blue collar workers women constituted roughly one-half of all laborers, 33% of operatives and less than 10% of craft workers. Needless to say, in both white and blue collar occupational groups women held the least prestigious, lowest paying jobs in the industry.

An analysis of the distribution of jobs among occupational classifications in the GMSV industry in 1982 showed that over 70% of employees worked in white collar jobs and half of those in the group held professional positions. Although 41% of men working in GMSV were employed as professionals only 20% of women in the industry held comparable jobs.

An even greater disparity was demonstrated by employees classified as officials and managers. Eighteen percent of men in the industry held these positions while only 3% of women were employed in managerial or official capacities. Table IV-B presents further detail covering the distribution of jobs for women and men in GMSV.

Occupations and Outlook

The outlook appears to be generally favorable for employment in the guided missiles and space vehicles industry. Although detailed occupational statistics are not available for the industry WOW has identified major job categories in the industry and provides projections for these occupations (for all industries) in Table IV-C.

As indicated in the above sections there are high proportions of professional and technical jobs in GMSV. These include aerospace, electrical, electronic, industrial and mechanical engineers, engineering and science technologists and technicians, computer scientists, mathematicians and physical scientists among others. Based on company responses to WOW's requests for occupational information we found that many corporations are actively recruiting for entry-level and experienced personnel in all of these fields. [Information about specific careers can be found among the **Occupational Profiles.**]

TABLE IV-A.

SELECTED DEMOGRAPHIC CHARACTERISTICS
OF THE
GUIDED MISSILES AND SPACE VEHICLES INDUSTRY
1982

	Total Number	Number Women	% Women	% White Women	% Minority Women
Total Employment	147,233	31,823	21.6	17.3	4.3
Total White Collar	103,414	23,284	22.5	18.5	4.0
Officials and managers	21,921	960	4.4	3.8	0.6
Professionals	53,787	6,482	12.1	10.2	1.9
Technicians	9,548	1,964	20.6	16.0	4.5
Sales workers	116	16	13.8	12.9	0.9
Office and clerical workers	18,042	13,862	76.8	62.7	14.2
Total Blue Collar	41,874	7,976	19.0	14.5	4.6
Craft workers	25,839	2,237	8.7	6.4	2.2
Operatives	13,272	4,339	32.7	23.9	8.8
Laborers	2,763	1,400	50.7	44.4	6.2
Service workers	1,945	563	28.9	17.7	11.3

Note: Data covers 29 companies with 100 or more employees operating 78 establishments included under SIC 376 -- Guided Missiles and Space Vehicles and Parts.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983)

TABLE IV-B.

OCCUPATIONAL DISTRIBUTION BY SEX
FOR THE
GUIDED MISSILES AND SPACE VEHICLES INDUSTRY
1982

	All Workers % of total	Women Workers % of total	Men Workers % of total
Number	147,233	31,823	115,410
Total	100.0	100.0	100.0
Total White Collar	70.2	73.2	69.4
Officials and managers	14.9	3.0	18.2
Professionals	36.5	20.4	41.0
Technicians	6.5	6.2	6.6
Sales workers	0.0*	0.0*	0.0*
Office and clerical workers	12.3	43.6	3.6
Total Blue Collar	28.5	25.0	29.4
Craft workers	17.6	7.0	20.5
Operatives	9.0	13.6	7.7
Laborers	1.9	4.4	1.2
Service Workers	1.3	1.2	1.8

*Less than 0.1 percent employed.

Source: Equal Employment Opportunity Commission, EEO-1 Report Summary of Nationwide Industries (1983)

In addition to currently identifiable occupations in GMSV futurists predict there will be new job categories created in the space industry with titles such as celestial mechanic scientist, electron defrictionist, ionospheric plasmo physicist, lunar technician, planetary geologist, spacecraft controller and space mechanic.

It is important to note that most companies in GMSV recruit candidates for professional and technical positions who meet entry-level requirements (e.g. master's degree for engineers) and require little training to begin work. Additional professional training is generally provided through tuition reimbursement programs at local universities and technical institutes and not conducted in-house.

Given a high degree of anxiety among employers regarding perceived present and future shortages of qualified engineering personnel, steps are being considered by some firms to increase the productivity of this segment of the workforce by restructuring their approach toward on-the-job training and creating new job categories. Examples of these are apprenticing new engineers to more experienced personnel and introducing paraprofessionals such as engineering aides to handle elementary engineering tasks normally conducted by senior engineers.

Significant growth in space-related programs and activities will have a multiplier effect on those industries and occupations that provide technical support services to space agencies and firms. The types of businesses already involved as space contractors and subcontractors include many firms in the electronic components, electronic computing equipment, radio and television communications, engineering and scientific instruments, measuring and controlling devices and energy industries.

In addition, professional and technical occupations associated with industries that conduct successful scientific and commerical experiments in space through NASA programs may experience growth in the future. Given the development and use of new technologies necessary to meet the needs of advanced space programs, job opportunities will be greatest for those workers with high-level skills and advanced training.

General Industry Characteristics

Industry Concentration

The GMSV industry is highly concentrated compared with other U.S. manufacturing industries -- in other words, a few companies control a major proportion of industry sales. In addition, plant facilities tend to have large workforces and are located in only a few states.

According to the most recent federal government statistics on industry concentration (1977) the four largest firms in the

TABLE IV-C.

EMPLOYMENT PROJECTIONS FOR SELECTED OCCUPATIONS
IN THE
GUIDED MISSILES AND SPACE VEHICLES INDUSTRY*

	Employment (000s)		Percent Change
	Actual 1982	Moderate Trend 1995	1982-1995
Aero-astronautical engineers	44	62	41
Electrical engineers	320	528	68
Industrial engineers	160	227	42
Mechanical engineers	209	318	52
Math specialists	48	62	29
Electrical and electronic technicians	366	589	61
Mechanical engineering technicians	48	72	52
Computer specialists	521	943	81
Computer operating personnel	580	737	27
Electrical and electronic assemblers	281	362	27

*Data covers employment in all sectors of the economy.

Source: Silvestri, Lukasiewicz and Einstein, "Occupational Employment Projections Through 1995" Monthly Labor Review (November 1983), Table 1.

industry accounted for 64% of guided missile and space vehicle sales and the six largest firms covered the vast majority (94%) of industry sales. In 1982, 28 companies with 100 or more employees operated 78 facilities engaged in GMSV manufacture. The average employment per plant was over 1,800. In 1978 over 70% of the total value of industry shipments came from one state -- California.

Major Employers

The identities of many of the prominent corporations in the guided missiles and space vehicles industry are familiar based on their stature (in terms of sales) among U.S. manufacturing industries and their close association or involvement with general and military aviation. The following companies are major participants in GMSV manufacture.

Boeing Company, Inc.
Fairchild Industries Inc.
Ford Aerospace & Communications Corp.
General Dynamics Corp.
Grumman Aerospace Corp.
Lockheed Corp.
LTV Corp.
McDonnell Douglas Corp.
Martin Marietta Corp.
Rockwell International Corp.
TRW Inc.

Among these firms, Rockwell International was awarded the greatest number of contract dollars for GMSV and other projects by NASA in 1982 ($1,564 million), followed by Martin Marietta ($310 million) and McDonnell Douglas ($220 million). In addition, most of these firms received major contracts from the Department of Defense in 1982 including General Dynamics ($5.9 billion), McDonnell Douglas ($5.6 billion), Lockheed ($3.5 billion), and Boeing ($3.2 billion) (based on total contracts awarded.)

Although company-specific information pertaining to contracts for missile and space systems projects funded by DOD were not indicated, the Aerospace Industries Association of America reported that 53% of prime contract awards over $10,000 went to manufacturing facilities in the following regions in 1982: Pacific (46%), New England (13%), South Atlantic (11%), Mountain (10%) and other regions combined (20%).

Sales

The value of guided missile and space vehicle shipments was $10.5 billion in 1982. When adjusted for inflation estimated sales for 1983 show a slight increase and shipments for 1984 are projected to grow more than 5% over the 1983 level. Although profits data were not readily available for GMSV manufacturers, the aerospace

industry as a whole demonstrated a profit decline in 1982 over the previous year. Profits as a percentage of sales -- the primary aerospace indicator -- dropped from 4.4% in 1981 to 3.2% in 1982.

According to industry analysts this experience was consistent with all other U.S. manufacturing industries whose profits on the average dropped due to the recession. The changing mix of government and commerical business in aerospace characterized by increasing government sales levels over the past few years and specifically in 1982 when commercial transport aircraft sales declined sharply also contributed to lower levels of profitability in the industry.

Research and Development Expenditures

According to estimates prepared by Battelle Memorial Institute, funding for aerospace research and development dropped 3.5% from 1982 levels to $11.8 billion in 1983 based on federal funding of $9.4 billion and corporate funding of $2.4 billion. Federal funding associated with aeronautical R & D activities is expected to grow through 1984 with the Department of Defense accounting for most of the increase. According to a National Science Foundation (NSF) study of industrial research and development expenditures, the aerospace industry significantly surpasses the average for all manufacturing groups.

While total DOD outlays for R & D activities are increasing at a rapid pace -- rates have been projected to grow by 14% between fiscal year (FY) 1982-83 and 17% between FY 1983-84 (based on constant dollars) -- NASA's budgets for all R & D projects declined between FY 1982-83 and are estimated to remain at 1983 levels in FY 1984. Although these projections might place NASA in a precarious position, there is recent evidence of a turnaround based on increased Congressional support for a manned space station.

Foreign Trade

The guided missile and space vehicle industry industry makes a positive contribution to the balance of trade because it exports but does not import products. In 1984 the DOC projects the industry level of GMSV exports (primarily missiles) will increase 15% over 1983. The industry exported less than 7% of its total production during 1983. The aerospace industry also demonstrates strong trade performance characteristics with export sales significantly greater than import sales.

Trends in Space and Missile Programs

According to GMSV industry analysts, a "new era" is emerging for space programs. The industry has and will continue to play a major role among high technology as well as other U.S. manufacturing industries in the future. Two key factors -- the

space shuttle and increased military space projects -- will likely contribute to the growth of the GMSV industry as well as related manufacturing, R&D and other firms engaged in space programs.

Space Programs

Projected growth in the GMSV industry over the coming years is based primarily on increased military space activities. According to industry experts fiscal year 1982 marked the first year since 1960 that budget authority for Department of Defense space programs exceeded NASA's. Authorizations for DOD and NASA were $6.4 billion and $5.5 billion, respectively (based on constant dollars -- base 1972). This represented a significant increase for DOD of 56% between FY 1981-1983 compared with only 9% over the same period for NASA space programs.

According to the AIA, the trend toward military predominance in federal space programs "is expected to continue in immediate future years as DOD begins Space Shuttle operations and simultaneously expands its space communications, intelligence gathering, navigation, meteorological, geodesy, and ground-based space surveillance programs."

The success of the space shuttle has made this program an integral component of the nation's space program and provided new directions for long-term space development. Studies are currently being conducted by the Administration to evaluate the possibility of developing a permanent manned space station and other long-range goals for new manned space activity.

If a space station is approved in the FY 1985 budget -- estimated initial development costs would be around $200 million -- industry experts project annual outlays increasing to $1 billion by 1987 with a station in operation by 1991. It goes without saying that growth in highly skilled technical occupations associated with this type of endeavor would potentially skyrocket.

One of the primary objectives for space station development is an increased interest in the scientific and commercial use of space -- the environment provides conditions that greatly increase the efficiencies of a number of processes including optical fiber production, biological processing, crystal formation, production of metal alloys and other industrial processes. A recent NASA-funded survey found 84 companies interested in conducting over 240 experimental and commercial projects in orbit.

In addition, overall space program expenditures are also based on the Administration's interest in increasing the utilization of space for military functions such as reconnaissance, surveillance, command and control, and communications activities.

Missile Programs

Missile systems production was also characterized by growth in 1982 with industry shipments valued at $5.4 billion in 1982. When missile propulsion systems and funding for research, development and evaluation are included, the AIA reported sales in excess of $8 billion for 1982. This figure represents a 13% increase in constant dollars over the previous year. This trend is expected to continue given Congressional approval of the Administration's request for $2.9 billion in federal funds for FY 1984 to support the Air Force's Peacekeeper (MX) intercontinental ballistic missile program (the largest missile system in the U.S.) and other strategic missile programs.

Sources of Information About the Industry

"Aerospace and Air Transport -- Basic Analysis", Standard & Poor's Industry Surveys (December 1, 1983), A15-A55.

Aerospace Facts and Figures. Washington, D.C.: Aerospace Industries Association of America, Inc. (July 1983).

Careers in Space. Greenbelt, Maryland: Goddard Space Flight Center.

Feingold, S. Norman and Norma Reno Miller, "Space Transportation Careers" (Chapter 11), Emerging Careers: New Occupations for the Year 2000 and Beyond. Garrett Park, Maryland: Garrett Park Press (1983).

Hager, Robert W., "The Technical 'Productivity Gap'", Astronautics & Aeronautics (May 1983), 66-70.

"How Reagan is Boosting Business into Space", Business Week (June 20, 1983), 52-53.

Kinnucan, Paul, "Space Business", High Technology (October 1983), 43-51.

Meyers, Randy and Gene Kingsbury, "Aerospace", U.S. Industrial Outlook 1984. Washington, D.C.: U.S. Department of Commerce (1984), Section 32.

"Putting America's Defense into Orbit" and "For Industry It's Almost Lift-Off Time", Business Week (June 20, 1983), 52-65.